Aviation Week & Space Technology

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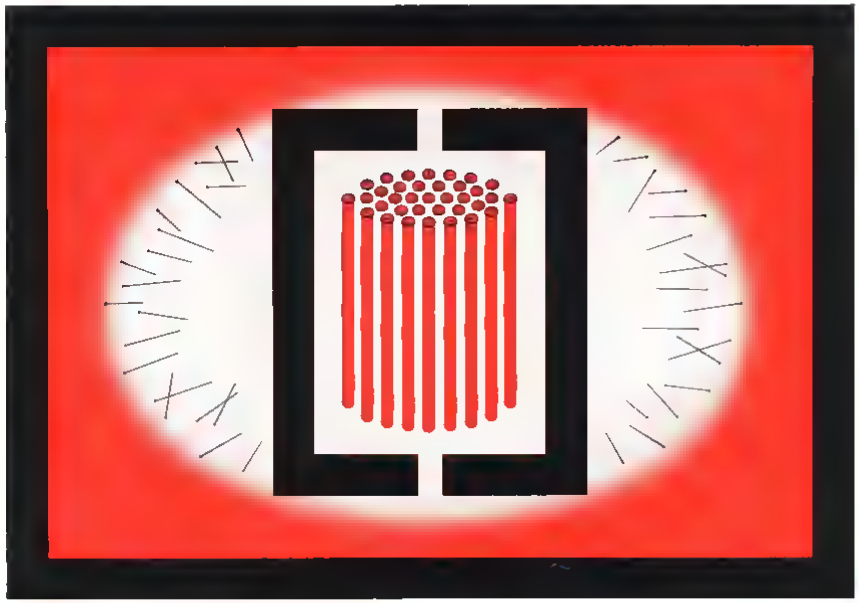
A McGraw-Hill Publication

March 18, 1963

PILOT REPORT:

Cessna 336 Skymaster

Douglas Saturn S-4 Production Line



ACHIEVEMENTS IN HIGH TEMPERATURE REACTOR TECHNOLOGY

1250°F LONG DURATION FUEL ELEMENTS—An AGN $BeO\text{-}UO_2$ element has been successfully tested for 10,000 hours at 1250°F Demonstrating long-term endurance for the ML 1 gas-cooled reactor this run broke all temperature time records

1850°F MATERIALS FOR COMPACT LIQUID METAL REACTORS—AGN has pumped cesium through a columbium loop for over 2,000 continuous hours of unattended operation at 1850°F

2260°F FEASIBILITY OF LIGHTWEIGHT SPACE POWER SYSTEMS—AGN has successfully generated 74 watts of electricity from a thermionic cell using lithium at 2260°F pumped through a columbium loop

4500°F SPACE PROPULSION REACTOR FUEL ELEMENTS—Economical manufacturing processes by extrusion for graphite and tungsten fuel elements capable of 4500°F operation have been reduced to practice—an AGN first

For further information on advances in the field of nuclear materials, write for AGN Active File No. 6

AGN

AEROJET-GENERAL NUCLEONICS/San Ramon, California

GENERAL TIRE

PRECISION FASTENERS
for demanding applications

Each of the fasteners described below was invented or fully developed by the creative abilities of Hi-Shear fastening engineers and fully evaluated in Hi-Shear research laboratories to resolve specific fastening problems.

Custom short or production long runs are fabricated in current materials including aluminum, alloy steel, stainless steel, carbon steel, titanium, A-286, N-115 alloy, Rene 41 and now maraging steels. Standard AN, NAS and MS fastener configurations are also produced.

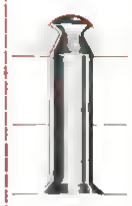
STRUCTURAL FASTENERS

HI-LOK® FASTENER

Given controlled preload and installation ease in tight areas with standard air motors and hand tools plus offering dual features of rivet and bolt-nut. Ideal to fasten metals, wood and fiberglass or combinations thereof. Extensively used in aerospace and marine shipyard industries. 5/32 thru 1 inch diameters. NAS versions available.

HI-TORQUE® BOLTS

Features unique Hi Torque™ recess in bolt head. Recess provides positive driver lock by torque alone. No end load is required. Recess permits highest design torque loads to install bolt with safety, tool retention and non-deformation of recess. Sealing version available. 4-40 thru 5/8 18 thread sizes. NAS versions available.



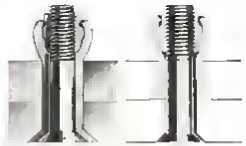
HI-SHEAR® RIVET

Still the most compact high strength fastener available today. Since alloy steel Hi-Shear rivets are about three times stronger than aluminum rivets fewer Hi-Shears are needed. This saves weight, space and time. Installed with standard rivet guns and squeezers. 1/8 thru 5/8 inch diameters. MS and NAS versions available.

BLIND FASTENERS

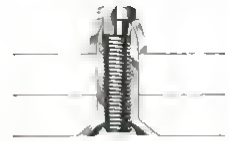
BLIND PRESS NUT™

Clinch type blind nut provides highly reliable bearing threads, inexpensive fastener in shear applications to secure attachment screws in thick or thin ductile metals. Self locking . . . accommodate coarse or fine thread screws from 4-40 thru 3/8 16 and 3/8-24.



BLIND BOLT™ — BLIND NUT™

All purpose, high strength self locking, blind fasteners for structural assembly, repair or modification. Highly suitable fasteners for blind or concealed structural areas. No grip sensitive. Blind Nut configuration ideal as replacement for stripped nutplate. Blind Bolts from 5/32 thru 1/2 inch diameter. Blind Nuts from 4-40 thru 3/8-24 thread sizes.



BETA BOLT™

Newest of Hi-Shear's proprietary fasteners. Self locking, blind fastener offering high residual tensile, shear and some fatigue values for attachment of skin panels, etc. Close tolerance shank pins 3/32 grip. Uses Hi-Shear developed 'sixcess' recess. Installation requires minimum end loads. Available in 5/32 thru 3/8 inch diameters.

OTHER RELATED PRODUCTS

P-SERIES PANEL FASTENERS

A self-aligning, self locking, spring loaded bolt for attachment of removable panels. Captive fastener design holds all parts to prevent loss while panel is removed. Uses single drilled or punched hole. No riveting. Uses Hi-Shear developed clinch type P-Nut. Single and double lead threads. 4-40 thru 1/4 28 bolt thread size; P-Nuts from 4-40 thru 3/8 24 threads.

INSERT

Stainless steel insert provides load bearing, wear resistant, self locking threads in plate or cast aluminum drilled hole only. No counterboring or tapping required. Simple installation. Coarse and fine threads from 8-32 thru 3/8-16 and 3/8-24.

ANCHOR BUSHING®

Used with inexpensive lightweight drill jigs to obtain hole location and drill perpendicularity. Various types are riveted, spot welded or pressed into sheet metal templates. Other types are imbedded in laminate plastic drill templates. Three hole nutplate configuration also available. Drill sizes accommodated: #55 (.0520) thru 7/16 (.4375)

U. S. AND FOREIGN PATENTS GRANTED AND APPLIED FOR

hi-shear CORPORATION

2600 West 247th Street
Torrance, California, U.S.A.
Area Code 213, 775 3181

AEROSPACE CALENDAR

Mar 25-28—International Convention, Institute of Electrical and Electronics Engineers, Waldorf-Astoria and Coliseum, New York, N Y

Mar 26-27—Conference Problem of Obsolescence of Engineering Skills, Illinois Institute of Technology, Chicago, Ill Sponsors IIT, Executive Office of the President, Office of Emergency Planning

Mar 28-29—Fifth International Symposium on Electron Beam Technology Hotel Sheraton Plaza, Cambridge, Mass Sponsor Alloyd Electronics Corp

Apr 1-3—Launch and Space Vehicle Shell Structures Conference, American Institute of Aeronautics and Astronautics, El Mirador Hotel, Palm Springs, Calif

Apr. 2-3—Eighth Annual Business Aircraft Safety Seminar, Flight Safety Foundation Barbizon Plaza, New York, N Y

Apr 2-5—Spring Conference, Airport Operators Council, Shoreham Hotel, Washington, D C

Apr 3-4—Air Line Pilots Assn.'s Air Safety Forum, O'Hare Inn, Chicago, Ill

Apr 8-11—National Aero-Nautical Meeting, Production Forum & Aerospace Support Equipment Conference, SAE/American Society of Naval Engineers, Sheraton-Park Hotel, Washington, D C

Apr 10—1963 National Value Engineering Conference For information Dr David Miller coordinator of special programs, Los Angeles State College, 5151 State College Dr, Los Angeles 32, Calif

Apr 10-11—Fourth Symposium on Engineering Aspects of Magnetohydrody-

(Continued on page 7)

AVIATION WEEK & Space Technology

March 18, 1963
Vol 78, No 11

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AEROSPACE CALENDAR

(Continued from page 5)

namics, University of California, Berkeley.

Apr. 10-11—Photovoltaic Specialists Meeting, Institute of Electrical and Electronics Engineers, Statler Hilton Hotel, Washington, D.C.

Apr. 16—Institute of Navigation's Western Region Meeting, Charter House Hotel, Anaheim, Calif.

Apr. 16-18—National Meeting, Aerospace Industries Assn.'s Export Committee, Gramercy Inn, Washington, D.C.

Apr. 16-18—Optical Masers Symposium, Waldorf-Astoria, New York, N.Y. Sponsors: Polytechnic Institute of Brooklyn, Institute of Electrical and Electronics Engineers, American Optical Society, Armed Services.

Apr. 16-19—1963 USAF Aerospace Fluids and Lubricants Conference (unclassified), San Antonio, Tex. Managed by Southwest Research Institute.

Apr. 17-19—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Statler Hilton Hotel, Los Angeles, Calif.

Apr. 17-19—International Nonlinear Magnetics (INTERMAG) Conference, Institute of Electrical and Electronics Engineers, Shoreham Hotel, Washington.

Apr. 17-19—Southwestern Conference and Electronic Show, Institute of Electrical and Electronics Engineers, Dallas Memorial Auditorium, Dallas, Tex.

Apr. 17-19—Technical Meeting, Nuclear Materials for Space Applications, American Nuclear Society, Netherland Hilton Hotel, Cincinnati, Ohio.

Apr. 22-23—Annual Meeting, National Aeronautical Services Assn., Washington, D.C.

Apr. 22-24—Second Manned Space Flight Symposium, AIAA/NASA, Marriott Hotel, Dallas, Tex.

Apr. 22-24—Third Annual San Diego Symposium for Biomedical Engineering, Del Webb's Oceanhouse, San Diego, Calif.

Apr. 23-25—Hypersonic Ramjets Conference, AIAA/ASME, Naval Ordnance Laboratory, White Oak, Md.

Apr. 23-25—National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla.

Apr. 25-26—Annual Convention, Society of American Value Engineers, American Hotel, New York, N.Y.

Apr. 29-30—1963 Spring Meeting, Western States Section/The Combustion Institute, Vacation Village Motel, San Diego, Calif. Sponsor: General Dynamics/Astronautics.

Apr. 29-May 2—34th Annual Scientific Meeting, Aerospace Medical Assn., Statler Hilton Hotel, Los Angeles, Calif.

Apr. 29-May 2—22nd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton-Jefferson Hotel, St. Louis, Mo.

Apr. 29-May 2—Spring Meeting, United States National Committee of International Scientific Radio Union (URSI), National Academy of Sciences, National Research Council, Washington, D.C.

Apr. 29-May 3—Annual Conference, Society of Photographic Scientists and Engineers, Ambassador Hotel, Atlantic City, N.J. Co-sponsor: Army Research Office.

(Continued on page 9)

AEROSPACE CALENDAR

(Continued from page 7)

May 1-3—19th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D.C.

May 1-9—Third National Conference on the Peaceful Uses of Space, Chicago, Ill.

May 2—Manned Space Laboratory Conference, AIAA/Aerospace Medical Assn., Statler Hilton Hotel, Los Angeles, Calif.

May 2-3—Fourth National Symposium on Human Factors in Electronics, Institute of Electrical and Electronics Engineers, Marriott Twin Bridges Motel, Washington, D.C.

May 2-5—International Travel Fair and Flying Display, Biggin Hill Airport, Kent, England.

May 5-8—1963 Annual Conference, American Assn. of Airport Executives, Galt Ocean Mile, Beach Club and Coral Ridge Hotels, Fort Lauderdale, Fla.

May 6-8—Aerospace Reliability and Maintainability Meeting, AIAA/ASME/SAE, Washington, D.C.

May 7-9—Electronic Components Conference, Institute of Electrical and Electronics Engineers, International Inn, Washington, D.C.

May 9-10—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Fort Worth, Tex.

May 13-15—National Aerospace Electronics Conference, IEEE/AIAA, Dayton, Ohio.

May 15-17—Connecticut General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.

May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Miramar Hotel, Santa Monica, Calif.

May 20-22—National Telemetering Conference, Hilton Hotel, Albuquerque, N.M.

May 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.

May 21-24—25th Annual Meeting and News Conference, Aviation/Space Writers Assn., Adolphus Hotel, Dallas, Tex.

May 27-28—Seventh National Conference on Product Engineering & Production, Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.

June 3-11—COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland.

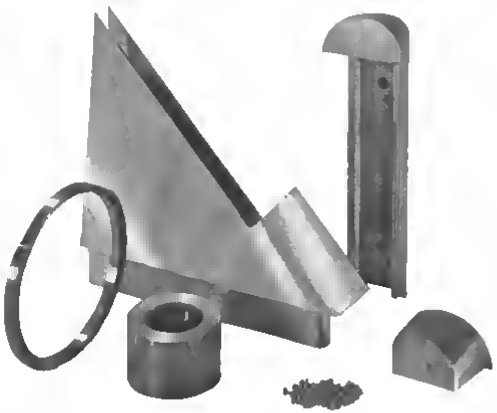
June 6-7—Symposium on the Exploration of Mars, Denver Hilton Hotel, Denver, Colo. Sponsor, American Astronautical Society. Co-sponsors, American Astronomical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections, NASA.

June 7-8—14th National Maintenance & Operations Meeting, Reading Aviation Service, Reading, Pa.

June 7-16—25th French International Air Show, Le Bourget, Paris, France.

June 17-20—Summer Meeting, American Institute of Aeronautics and Astronautics (AIAA), Hotel Ambassador, Los Angeles.

June 28-July 3—Second Annual Dorado Fly In, Dorado Beach Hotel, Dorado, Puerto Rico.



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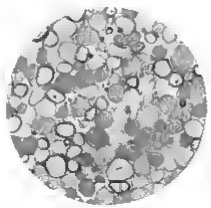
This family of Mallory materials is exceptionally fine for gyro rotors. The Gyromet® materials have superior strength, and can be used at rotational speeds up to 120,000 RPM. And we have another material whose coefficient of expansion approaches that of beryllium.

Another feature of these materials that you may find useful in quite different applications is their thermal properties. They have good thermal conductivity . . as high as 0.325 CGS units . . . resist oxidation and corrosion, and maintain high strength at moderately elevated temperatures. Their coefficients of expansion are about half that of steel.

From our continuing research, we have recently developed new materials with even higher densities and others with better physical properties than ever before. If you'd like to discuss ways that these unusual materials might be used on your specific projects, write or call us today. Mallory Metallurgical Company, P. O. Box 1582, Indianapolis 6, Indiana—a division of P. R. Mallory & Co. Inc.



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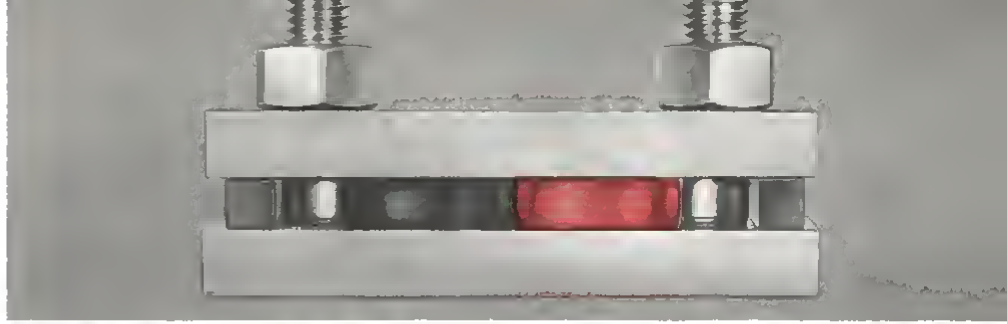
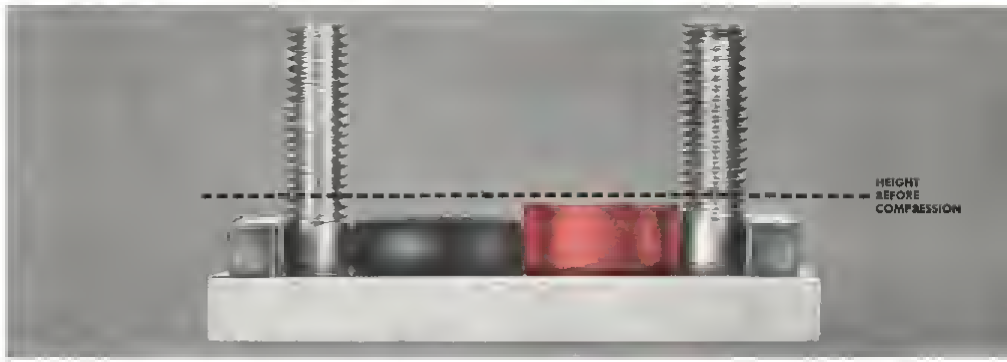
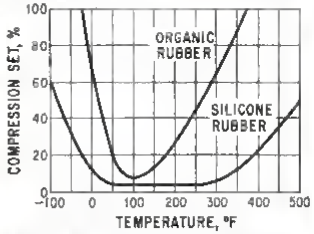




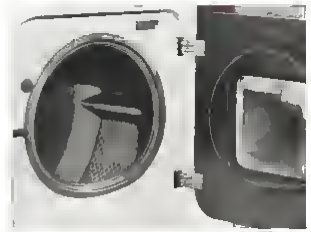
Under compression at 450° F., all rubbers are disappointing except silicone rubber

Although many elastomers offer good "come back" after compression at ordinary temperatures, General Electric silicone rubber has excellent compression-set resistance from −120°F to +500°F. This is one of many properties that make silicone rubber useful when the environment is too tough for other elastomers. Silicone rubber resists temperature extremes, ozone, moisture and aging, and retains much of its excellent physical strength and electrical properties throughout its wide operating range.

Automotive transmission seals oil seals and other automotive parts efficiently utilize the superior physical strength, the outstanding resistance to the combined effects of heat, compression and oils and the excellent flexibility of G E silicone rubber.



No other elastomer even comes close to matching the unique compression-set resistance of silicone rubber from −120°F to +500°F. For any sealing application where high or low temperature operation is anticipated, there is no substitute for silicone rubber.



Washer-dryer door gaskets of G E silicone rubber continue to provide water-tight seal at high temperatures after years of service. Silicone rubber was specified for its resistance to temperature, compression corrosion, staining, aging and moisture.

General Electric silicone rubber is available from a number of qualified fabricators. For additional information about the outstanding properties of General Electric silicone rubber, write: General Electric Company, Silicone Products Department, Section J385, Waterford, New York.

GENERAL ELECTRIC

COMBAT PROVEN

*Army Press Release — January 1963

Today, the UH-1 Iroquois is "writing the book" on helicopter combat tactics. Equipped with rockets and machine guns, these hard-hitting choppers are decisively proving Army Aviation's air mobility concepts in Vietnam. Hitting hard and fast they escort troop-carrying helicopters and provide protection in objective areas with heavy firepower. On mercy missions, the Iroquois evacuates combat casualties. ■ Iroquois are designed and built for combat service. High performance, compact silhouette, all environment proven, the UH-1 is matched to the task of guerrilla warfare. And in Vietnam its combat record is the record of Army Aviation.

BELL HELICOPTER COMPANY
Fort Worth, Texas
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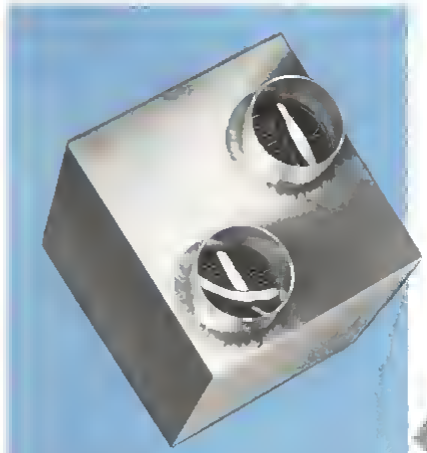

FOR MEN—cryogenic type heat exchanger for cooling astronaut pressure suits.

FOR MISSILES—air-to-air type heat exchanger for cooling electronic equipment compartments.

COOLERS FOR MEN AND MISSILES BY GM-HARRISON!

EXPERIENCE— GM-Harrison experience—leads to important advances in temperature control equipment for the space age. Harrison's answers to heat transfer problems are based on broad experience in many fields—*aero/space, nuclear, automotive, marine and industrial.* And to come up with temperature control equipment *MATCHED TO THE JOB,* Harrison engineering teams choose from a *complete* line of basic designs. At Harrison, it is this *experience* and *selectivity* which provides heat exchangers with an optimum combination of performance, reliability and economy.

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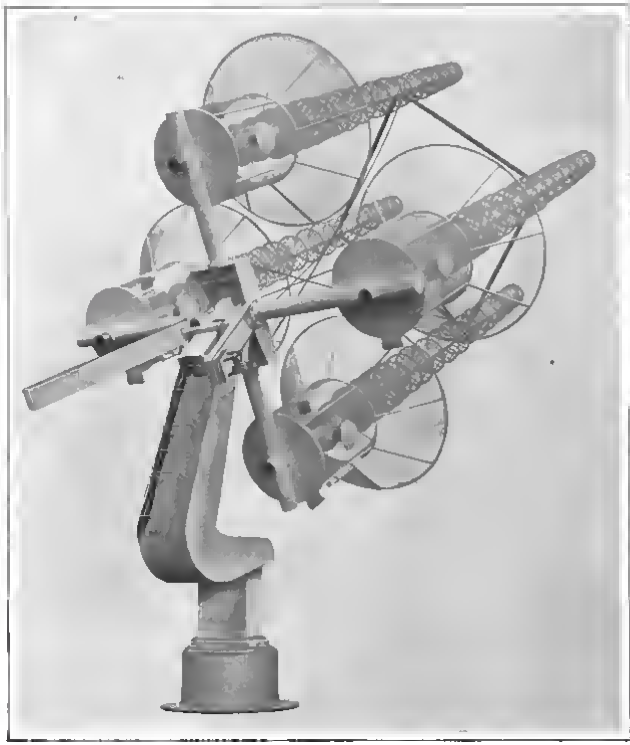
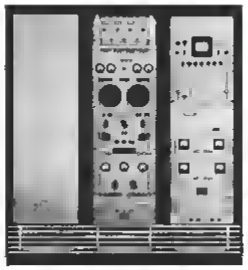
HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK





Complete automatic telemetry tracking systems . . . priced from $25,000 to $250,000

Cubic telemetry tracking systems cover the complete spectrum of frequencies, performance, and price. For example, the Cubic AGAVE system shown in the illustration is complete and ready to perform automatic aerospace tracking. It includes the antenna system mounted on a pedestal, a three-bay electronic cabinet, plus servo and tracking receiver systems. This particular system sells for $70,000. Other Cubic telemetry and tracking systems sell for as little as $25,000 or as much as $250,000, depending on the features desired. Cubic AGAVE's have performed flawlessly as the primary acquisition equipment for Project Mercury, as well as in a variety of other applications.

Cubic is able to offer this wide range of telemetry tracking systems at very competitive prices since Cubic has performed the major research and development, and delivered such a large volume of systems. Because of the wide spectrum of equipment available, Cubic engineers can meet the requirements of range operators and eliminate costly development time. For further information on Cubic AGAVE tracking systems, write for Technical Memorandum 102, Dept. B-128.

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The versatile, lightweight RYANAV IV tells the pilot *where* he is, how to get to his *destination* and return *home* regardless of flight path and altitude. This unique capability enhances mission success and reduces pilot workload.

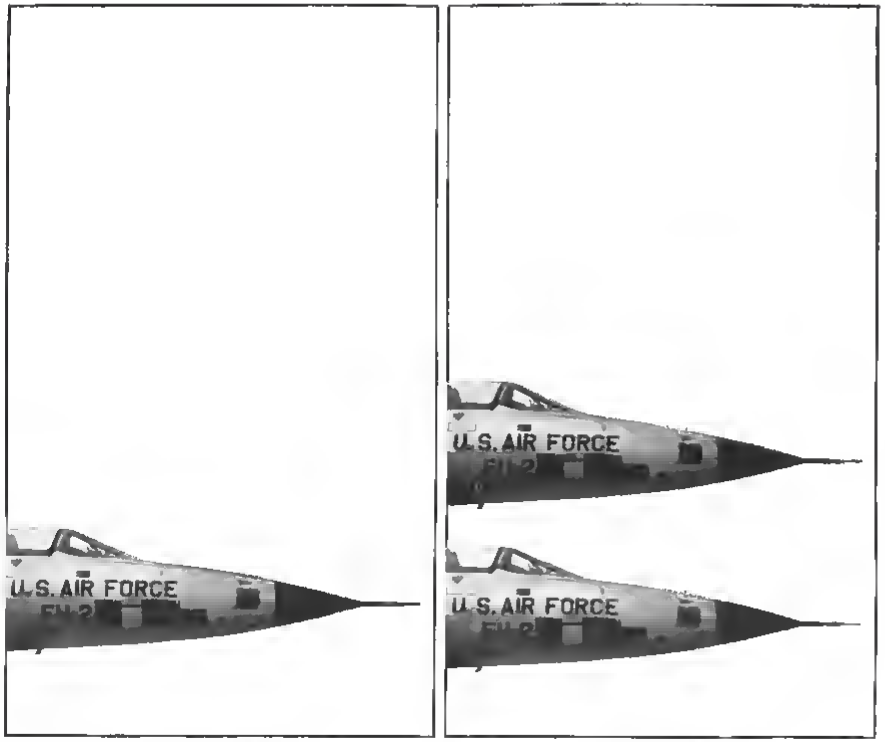
Ryan scientist-engineering teams are also deeply involved in programs which include: creation of the newest in V/STOL aircraft; applications of the Ryan Flex Wing; advanced models of Ryan's Firebee jet target drone, lunar landing systems, space radar systems, precision antennas, and lightweight structures for space vehicles such as Mariner II, Saturn and Surveyor.

Your inquiry is invited on how Ryan's spectrum of capabilities can help solve your problems from space structures to weapons systems.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

FOR LIMITED WARFARE. Over strange jungle regions, deserts, mountains, seas, Ryanav IV is accurate, reliable and designed for ease of maintenance.

RYAN ELECTRONICS



6500 man-hours to assemble

6500 man-hours to assemble

During the past two years, we have halved the cost of assembling the nose section of the F-105 fighter-bomber. (That's 5,500 major parts, excluding fasteners.)

This saving of 3250 man-hours is just a small part of the nearly $900,000 we have chopped off the total unit flyaway cost of the F-105. And when we say "flyaway," we mean with all systems and equipment in and tested and operating.

Not that we've done it all by ourselves. F-105 costs have been reduced (1) at the Republic plant, (2) by the thousands of small business firms who have received over 82% of our sub-contract purchase orders, and (3) by the suppliers of government furnished aircraft equipment, to whom we have given cost-control assistance with full Air Force cooperation.

In its first two years of operation, Republic's cost-management program saved the Air Force $226,300,000. Today we are still working to reduce continuously the total cost of the F-105 weapon system, without impairing function or reliability.

How much does an F-105D cost, now, as you are reading this message? Less than it did when this message was written.

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AVIATION CORPORATION

Volume 78
Number 11

Aviation Week & Space Technology

March 18, 1963

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COVER: S-4 stages for Saturn 1 vehicle are on the production line at Douglas Aircraft Corp.'s Missile and Space Systems Div., Santa Monica. S-4s have been delivered to NASA's Marshall Space Flight Center and Cape Canaveral for dynamics testing and systems check-out, and to determine mode of future shipment of large space vehicles from West Coast.

PICTURE CREDITS
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EDITORIAL

The Secrecy Boomerang

The Kennedy Administration is obviously bewildered by the persistence and the scope of attacks on its major policies in the field of foreign relations and defense that have driven it back into defensive positions at a time when it expected to be basking in the sun of public plaudits for its actions. Its bewilderment over why this has happened is rather sad, because it is obvious to most of its critics and questioners that the primary reason for this state of affairs has been the boomerang of its policies of official secrecy and attempted management of the news. Top-level Administration officials from the President through the Defense and State Departments feel the heavy impact from this boomerang, but don't appear yet to know that it was launched many, many months ago from their own hands.

The Kennedy Administration began its tenure with an amateurish approach to the problems of military security, perhaps because so few of its top-level policy makers had had much prior experience with this subject in its modern context. They were horrified by the amount of information available through normal channels, and they had no real appreciation of what was genuine military security and what information was really necessary to lubricate the wheels of technical progress in the type of society we are dedicated to maintaining. They looked cautiously at the tight information control in the closed society of the USSR, and, whether deliberately or subconsciously, they began to emulate many of its worst features. There is also a theory that these Administration information policies stemmed from the Boston Brahmin tradition that even though democracy prevailed, it should be operated by a special class of superior people who should tell those they governed as little as possible about what is really being done with their tax dollars, and government.

Policy of Deception

At any rate, when the first major crisis of the Kennedy Administration broke in the Bay of Pigs, it adopted the policy, later advocated so shrilly by Arthur Sylvester, assistant secretary of defense for public affairs, that the government has a right to lie in an attempt to deceive an enemy, even if this also means deceiving its own people. It is now evident that the government did a great deal of lying about what went on just before and during the Bay of Pigs fiasco. While this official lying may have been intended to deceive the enemy, we think it would be difficult to make a valid case on this score. The subsequent record suggests that it was really motivated by a self-serving desire to preserve a governmental image that the facts would not support.

In any event, the Administration made its decision at the time of the Bay of Pigs invasion to manage the news to suit its own ends, and it has continued to try to do so in every major international crisis since. In a free society with a free press it is difficult to suppress the facts for long, and it is impossible to manage the news very effectively to maintain the desired image for very long if the facts do not support it. Thus the facts have been popping up about what really occurred in Cuba from the Bay of Pigs to the missile crisis of last fall, and each new fact pulls a prop out from under the version dispensed by the official news managers and their talented amateur assistants. Each new fact that proves to be at variance with the official stories told at the time also erodes public confidence both at home and abroad in the integrity and credibility of the public officials involved.

This is why the Kennedy Administration is receiving precious little credit for any of its recent maneuvers, even when those maneuvers, if fully and honestly explained, would merit plaudits instead of brickbats. The entire problem of NATO nuclear deterrent forces has been handled with the same cavalier disregard for the facts and crudely managed attempts to conceal what is really occurring. From the Skybolt cancellation through the Polaris submarine and surface ship NATO deterrent proposals, it is difficult for anybody here or in Europe to follow the swift shifting of contradictory justifications under which real motivations and policy are thinly concealed.

Suspicion Abroad

There is now a widespread suspicion in Europe as a result of all this that there is some secret or tacit agreement between the White House and the Kremlin involving a U.S. nuclear disengagement in Europe in exchange for the Soviet withdrawal of missiles and troops from Cuba. Certainly the net result of the Skybolt fiasco was to take Britain out of the effective nuclear deterrent business for a long time. When the real costs of Polaris submarines are faced in the British defense budget, this proposed force will disappear like a mirage. The withdrawal of Jupiter IRBMs from Turkey and Italy appears to be part of this pattern, even though the Administration stoutly denies it. The ire directed against the French effort to maintain a nuclear striking force under its own flag also lends credence to this theory.

It is ironic that the louder the Kennedy Administration now denies these rumors, the more credence they gain because people remember the similar denials and assurances given at the time of the Cuban crises that later proved to be deliberate errors of fact justified in the name of expediency.

This nation is still a free society and its policies must rise or fall on their degree of public support. The people of this nation are not used to being deliberately deceived by their elected or appointive officials, nor will they tolerate it for long. Until the Kennedy Administration recognizes this simple fact and revises its methods of explaining its policies to the American people, it is likely to encounter increasing suspicion of its motives and diminishing support for its policies. —Robert Hotz

WHO'S WHERE

In the Front Office

Leland R Taylor, a director, and **Dr Howard Reiss** a vice president North American Aviation Inc, El Segundo Calif Mr Taylor continues as vice president and assistant to the president, Dr Reiss continues as director of North American's Science Center, Canoga Park Calif

L L Farnham and **Charles Collis** vice presidents of Fairchild Stratos Corp Mr Farnham continues as corporate director of advanced engineering with immediate attention on the Meteoroid Detection Satellite program; Mr Collis has overall responsibilities for the Stratos Div Bay Shore N Y, and the Electronic Systems Div, Wyandanch N Y

John S Liefeld, vice president-operations Astro Structures Div of Lear Siegler Inc El Segundo Calif

H O Bales, president Navan Products Inc, subsidiary of North American Aviation Inc El Segundo Calif and **W H Cann**, North American vice president and secretary elected Navan's board chairman **C E Hart** becomes secretary of Navan

Henri J Lesieur will become counselor to Air France's general management in Paris as of Aug 1 **Henri Marescot** will succeed M Lesieur as general manager of the North Central American and Caribbean Div

Richard D Geckler vice president future operations a new position on the corporate staff of Aerojet General Corp Azusa, Calif Also **Robert B Young** vice president Sacramento Plants a new position involving management consolidation of the Liquid and Solid Rocket Plants **E S Reichard, Jr.**, vice president contracts a new position on the corporate staff

TRW Electronics El Segundo, Calif a subsidiary of Thompson Ramo Wooldridge Inc has appointed **Q T Wiles** as vice president and general manager of a division comprised of the following operating units Microwave Good All Capacitors Good All Rectifiers and Milam Electric Mfg Co Also **Sidney L Spiegal** vice president marketing TRW Electronics

Walter L. Lingle assistant administrator for management development National Aeronautics and Space Administration will take a newly created job as deputy associate administrator for industrial relations **Albert F Siepert** director of administration will take a newly created job as deputy director of NASA's Launch Operations Center Cocoa Beach, Fla Mr Siepert will be replaced by his deputy **John D Young**, **Don Cadle** director of resources programming Programs Office will succeed Mr Young Capt **Robert F Freitag** USN will be detailed to NASA as launch vehicles director manned space flight office replacing **Milton W Rosen** (AW Feb 25 p 41) who becomes senior scientist in Adv W F Boone's defense affairs directorate

Col Roy W Nelson, Jr, commander Air Weather Service of the Military Air Transport Service (MATS) succeeding Brig Gen **Norman L. Peterson**, who assumes command of the USAF Pacific Communications Area with headquarters in Hawaii

(Continued on page 109)

INDUSTRY OBSERVER

► Powerplant choice for the Phoenix air-to-air missile armament for General Dynamics-Grumman F-111 tactical fighters is expected to be made next month by Hughes Aircraft Co which is responsible for development of the missile system Hughes engineers now are evaluating potential suppliers and both solid and packed-liquid propellant motors

► Special high-power optical masers are being developed by three companies under an Advanced Research Projects Agency program, to evaluate their possible use as radiation weapons The companies are American Optical, Hughes Aircraft and Westinghouse Contracts are administered by Office of Naval Research, and are outgrowths of more than a dozen short studies conducted by industry last year (AW Apr 16, p 28) Other studies for materials improvements in glass and ruby are being funded by ARPA

► Solid-propellant nitrogen rocket motors programed for installation on Lockheed Missiles & Space Co's Agena D spacecraft will be tested at National Aeronautics and Space Administration's Langley Research Center to determine if metal additives should be removed in the propellant There is belief that interference with radio transmission from the spacecraft could be created by metal particles carried along into the jet exhaust

► Army is urging propulsion contractors to take another look at cost reduction for solid-propellant rocket motors Examples cited include the first-stage Pershing motor, consisting of a lightweight steel case and nozzle, an igniter and 4,500 lb of propellant Cost of the unit in production is estimated at $43 000 Nike Hercules sustainer motor, which contains about 2,100 lb of propellant, still costs above $6,400 after production of many thousands

► Watch for formation of a three-nation flight group this summer to evaluate the Hawker P.1127 VTOL strike fighter at Dunsfold England Arrangement follows the West German signing of a test agreement with the British and U S Hawker is building 15 aircraft, nine of them will be assigned to the three-nation squadron and six to the Royal Air Force

► Royal Canadian Air Force is conducting informal operational requirements checks on a number of 8- to 12-passenger jet aircraft as a preliminary move in a program which could result in the purchase of 100 aircraft for utility, liaison and training missions Among the aircraft being evaluated North American T-39 Sabreliner, de Havilland DH 125 and Lockheed C-140 Jet Star Program is expected to call for purchase of aircraft in small increments

► Bell Helicopter Co's modified high-speed UH-1B (AW Dec 10 p 52) currently is being flown with paddle-shaped blades on the three-bladed rigid rotor Tip chords of the blades have been lengthened to increase the airfoil fineness ratio and overcome compressibility problems encountered at high rotor rpm and high speeds

► Beech plans for a new version of its four-place Bonanza business plane were inadvertently revealed when a prototype of the new model crashed during flight tests of spin characteristics with deliberate loading to place the center of gravity in an abnormally far aft position Pilot parachuted safely New model has a conventional horizontal and swept vertical tail replacing the Vee-tail of the standard Bonanza. Plane is believed to have more installed horsepower than the 260-hp Continental engine in the latest P35 Bonanzas

► Watch for British government support of a communications satellite network as a national and Commonwealth project Conservative Party's Space and Technology Committee claims the satellite could be in orbit in about three years for a cost approximating $550 million Design work has started at Royal Aircraft Establishment, Farnborough De Havilland Blue Streak would be the first stage, boosting a Black Knight second stage vehicle

► Two successful zero-length launches of a dummy mass representing the F-104 Starfighter have been made by Lockheed California Co West German air force F-104s will have a capability of being fitted with a zero-length launch booster of approximately 65,000-lb thrust, made by North American Aviation's Solid Rocket Div (AW Feb 25, p. 27)

Washington Roundup

The Cuban Shadow

Presence of Soviet troops and defensive weapons in Cuba continues to be a major problem for the Administration, despite Russia's removal of offensive weapons from the island last year. Twelve of the 14 questions asked by the audience after Secretary of State Dean Rusk spoke to the 19th conference of the Advertising Council here last week concerned Cuba. The TFX investigation (see p. 26) got more attention than Cuba when Deputy Defense Secretary Roswell Gilpatric appeared as guest on a question-and-answer television program, but Gilpatric was asked: "If you never knew how many missiles were brought into Cuba, how do you know that all that went in went out?"

"Our estimate was based on the number of installations and what we believed to be the order of battle associated with each installation," Gilpatric replied. "In other words so many squadrons, so many units of missiles and from that we derived certain computations. We never could be completely sure but it is still the position of the government today that all of the missiles were—and the other weapons which we considered to be offensive, that is which have a capacity for inflicting major damage on the United States—have been removed."

An Eisenhower Echo

Regarding the TFX award Gilpatric said it is "perfectly proper" for a congressman whose state loses an award to ask for an investigation. But he said he would not like to "see every award investigated at the instance of the disgruntled contractor. We could never get any business done." Then he harked back to former President Eisenhower's remarks in his farewell address about "the unwarranted influence, whether sought or unsought, by the military industrial complex" (AW Jan. 23, 1961, p. 31). "And it does give me concern," Gilpatric said, "that if the military, taking the same side as a particular contractor, do cause a civilian decision to be investigated . . . perhaps the things that President Eisenhower talked about . . . have more substance than I had previously credited them."

Government management of the news, particularly during the Cuban crisis last fall, will be explored this week by the House Government Information Subcommittee. News organization witnesses will testify Mar. 19. On Mar. 21, Assistant Secretary of Defense for Public Affairs Arthur Sylvester and Assistant Secretary of State for Public Affairs Robert Manning will be the first government witnesses. National Aeronautics and Space Administration and Atomic Energy Commission witnesses will be called, and testimony from security and intelligence witnesses may force the "freedom of information" subcommittee to hold the first closed sessions in its 7½ year history. One possible result of the hearings is a set of guidelines for release of information in less than hot war situations.

Soviet Nuclear Tests

Intensive new series of Soviet nuclear tests is expected by key Administration officials unless Russia surprises the U. S. with a reversal of attitude in the Geneva test ban talks. Since Russia broke a three-year test moratorium on Sept. 1, 1961, Atomic Energy Commission has reported two Soviet test series. The first, in September and October of 1961, included approximately 50 atmospheric tests and an underwater test. The second, from August to December of last year, included tests unofficially estimated at more than 70. AEC identified one Soviet underground test, on Feb. 2, 1962.

U. S. has conducted approximately 100 weapons-related tests in Nevada and in the Pacific since Sept. 15, 1961. Last announcement of U. S. tests concerned two underground shots last Feb. 21.

Somali is the latest independent African country to ask the U. S. for technical aid instead of seeking it from former rulers. Somali had been divided between Britain and Italy and still operates under British and Italian aviation rules. But it turned to the U. S. for assistance in revising and codifying these rules as the first step toward a national aviation system. Federal Aviation Agency representatives are in Somali now, under auspices of the Agency for International Development in response to the request.

Rancor Aweigh

General Accounting Office has completed a review of the 15-year, $1-billion nuclear aircraft propulsion program which was abandoned two years ago, and says that Defense Dept. "agrees that the program suffered considerably from lack of prompt decisions and from frequent changes in emphasis and goals."

Air Force Secretary Eugene Zuckert apparently is one of those who agrees. In a talk at Patrick AFB, Fla., recently, he ad libbed: "If the Air Force had had the counterpart of a certain much publicized Navy admiral, we might have a nuclear aircraft now."

Sylvester's Spadework

One senator emerged from the closed-door TFX hearing at which Arthur Sylvester, assistant secretary of defense for public affairs, attempted to explain his earlier criticism of the investigation last week (see p. 28) and said: "He wasn't satisfied with a 6-ft. grave. He had to dig himself a 100-ft. grave. If he had just said, 'I'm sorry, I goofed,' it would have been over in 10 min."

—Washington Staff

McNamara Assails Critics of TFX Award

Defense secretary defends choice on 'commonality' grounds; Navy details views on selection process.

By George C. Wilson

Washington—Senate probe of the F-111 (TFX) contract award will focus this week on Defense Secretary Robert S. McNamara's contention that the winning General Dynamics-Grumman design is more nearly a bi-service aircraft than Boeing's proposed tactical fighter and thus can be developed faster and cheaper.

In a sworn statement filed with the Senate Permanent Investigations subcommittee last week, McNamara said "the General Dynamics design would result in an airplane less expensive to produce, maintain and operate and more dependable both in training missions and in actual combat." He said "Boeing simply did not meet the fundamental requirement of minimum divergence from a common design" for the USAF-Navy fighter, and was unrealistic in its cost estimates.

This justification for choosing General Dynamics-Grumman came after a Navy spokesman challenged the entire concept of a bi-service fighter. George Spangenberg, evaluation division director at the Bureau of Naval Weapons, told the subcommittee the winning design will not meet the operational requirements originally specified. "Part of the reason, I am sure, for this extended program that we have been in is because we had somewhat irrational requirements to start with," Spangenberg said.

Chairman John L. McClellan (D-Ark.), after hearing McNamara's 32-page statement, said that it failed to explain several discrepancies disclosed by the subcommittee. He said the hearings will continue, with McNamara expected to be called to testify toward the end of the investigation.

McNamara filed the statement in an attempt to provide what he called "an overall framework" to put the testimony in perspective. "In my judgment," McNamara said in a letter to Sen. McClellan, "the fragmentary releases of portions of the testimony of witnesses who themselves are only familiar with part of the considerations underlying the decision in question have needlessly undermined public confidence in the integrity and judgment of the highest officials in the Department of Defense."

In his statement, McNamara said he and the civilian service secretaries chose General Dynamics-Grumman because "their proposal gave the most valid promise of obtaining a single airplane that can meet Navy and Air Force requirements with the least expensive, time-consuming research and development effort before production, the least reliance upon unknown process and materials, the earliest delivery to our fighting forces, the highest level of experience in building fighter-type aircraft, the greatest use of proven design techniques and methods, the most understanding of the requirements and difficulties in developing, testing, tooling and producing a fighter-type aircraft."

McNamara said the Defense Dept. often is saddled with cost overruns of from 300 to 500%. Thus, plus the enormous cost of modern weapons, demand that economies be implemented wherever possible, he said. Some cost overruns have been caused by setting performance standards "that go far beyond essential military requirements;" acceptance of unrealistically optimistic cost estimates at the beginning of a program," lack of an adequate definition of a project at the outset, and signing contracts without considering the contractor's past performance and without writing in incentive features.

McNamara said the F-111 program presented him with an opportunity to prove that producing a common item for two services would avoid these pitfalls and save millions. "The concept of a major multi-service weapons system is new," McNamara said. "I would be less than candid with you if I did not admit that the majority of experts in the Navy and Air Force said it couldn't be done." He said he became convinced that a single tactical fighter for both services would save "at least $1 billion in development, production, maintenance and operating costs."

He said the central theme of the F-111 effort was development of a weapons system that provided "minimum divergence," or commonality, between the Air Force and Navy versions.

The effort to attain the highest possible degree of commonality lies at the heart of the entire TFX endeavor. "My instructions on this point were clear and consistent." Despite the thousands of man-hours of evaluation that went into the F-111 project, McNamara told the subcommittee that "fundamentally we are dealing with a question of judgment. . . I do not feel this is a case which presents a civilian-military conflict, but rather one of placing emphasis where it must be placed. . . I found it necessary to balance the promises held out by competing contractors against the hopes and aspirations of military officers and the limiting realities of economics and technology. The decision was mine."

Although not denying that he and his service secretaries on four occasions reversed source selection board recommendations that Boeing be awarded the F-111 contract, McNamara said the secretaries were not the only dissenters. He made these points about the four evaluations which led to the award to General Dynamics-Grumman last November (AW Mar. 4, p. 24):

- **First evaluation.** He said the Air Force Systems Command dissented from the Air Force-Navy source selection board recommendation of January, 1962, that Boeing alone be awarded a contract to refine its tactical fighter design. AFSC agreed with the 235-member evaluation group that both General Dynamics-Grumman and Boeing be given that opportunity, McNamara said. (The Tactical Air Command, Air Force Logistics Command, and Navy Bureau of Weapons endorsed the source selection board's preference for Boeing.) McNamara said the Air Force Council also agreed with the evaluation group that both contractors should compete for an additional 90 days. McNamara said he raised "particular questions about the realism of the Boeing cost estimates" in approving continued competition.
- **Second evaluation.** McNamara said the source selection board's stated preference for Boeing in May, 1962, received only the qualified concurrence of the Navy member. He said Adm. George W. Anderson, chief of naval operations, felt it was premature to select Boeing unequivocally. The civilian secretaries gave both contractors three weeks to meet Navy objections to their designs.
- **Third evaluation.** Although the source selection board unanimously recommended Boeing again on June 20, 1962, McNamara said the Navy member "remained unconvinced that either of the new proposals met the Navy's requirements." McNamara said neither contractor appeared to fully understand that Defense Dept. truly wanted an airplane for both services.

(In his testimony, Spangenberg said that after the second evaluation the aircraft designs "deteriorated." He said General Dynamics gave the Navy six different configurations in 10 days in a crash effort to meet the service's objections, while Boeing "submitted a brand new airplane." He said 10 days was not enough time to perfect a final configuration, that Boeing had been working for some time on its Navy design and offered "a substantially better plane.")

McNamara said he directed Roswell Gilpatric, deputy defense secretary, to

Northrop Ranger Award

Washington—Northrop Corp., Beverly Hills, Calif., has been selected by the National Aeronautics and Space Administration to provide support to the Jet Propulsion Laboratory in the Ranger program through 1964, and to build, test and launch Ranger spacecraft beginning in 1965 (AW Feb. 25, p. 39).

Effective Mar. 11, Northrop began assisting JPL in design reviews, reliability studies, testing and checkout. Northrop also is to assist in Ranger launches before 1965. The contract for this phase, now being negotiated, will total about $2 million.

Selection of Northrop for the second phase, in which the firm would assume complete spacecraft responsibility, depends on performance in the first phase, NASA officials said.

JPL recommended more than a year ago that an industrial contractor be selected for production of Ranger spacecraft. Following the failure of Ranger 5 last fall, NASA appointed a review board which recommended, after its study, that support be provided to JPL.

NASA officials said the firm was selected on a sole source basis because of its familiarity with Ranger through contracts on two important subsystems: the attitude control system and the control computer and sequencer.

How TFX Investigation Was Initiated

Washington—Shortly after the Pentagon announced on Nov. 24 that the $6.5 billion F-111 (TFX) contract was going to General Dynamics-Grumman rather than the Boeing Co., Sen. Henry M. Jackson (D-Wash.) picked up a telephone in Honolulu and asked for what is proving to be the most significant procurement investigation since the end of World War 2.

Sen. Jackson, who was on his way to Vietnam when he telephoned Chairman John L. McClellan (D-Ark.) of the Senate Permanent Investigations subcommittee, insists he asked for the probe on his own and not at the suggestion of Boeing Co. officials. Boeing's home office is in Washington State, although Boeing would have built the TFX in Kansas.

"I had heard and read reports," Sen. Jackson said, "that challenged the integrity of the award. So I requested Sen. McClellan to get the truth about these allegations, which are serious. He promised to have the staff conduct a preliminary inquiry."

The subcommittee staff, after talks with F-111 procurement officials at Wright-Patterson AFB, Ohio, and in the Pentagon, uncovered everything from straight arithmetical errors of several million dollars to indications that technical analyses were ignored. So the subcommittee members, not without some fears of starting an unproductive battle of experts, unanimously voted to conduct hearings on the contract award.

Since Feb. 26, the subcommittee has been trying to unravel the extremely complicated series of events which led to what may be the last big aircraft production contract awarded by the Defense Dept. The principal witness in those first weeks was USAF Col. Charles A. Gayle, who became program director of the F-111 project after serving in the comparatively tranquil role of tactical fighter pilot.

Col. Gayle, whose superiors will follow him at the subcommittee's witness table, has been so equivocal in his answers that he has been dubbed 'the Casey Stengel of the Defense Dept.' by his questioners.

Sen. McClellan, now that he has started the investigation, is determined to see it through. "Our job is to make the record speak the truth,' he keeps saying. What was originally seen as a five- or six-day inquiry will continue for weeks.

Defense Secretary Robert S. McNamara found the hearings so disturbing he asked to break into the witness schedule long enough to justify his decision. But McNamara's 32-page explanation, filed with the committee, did not satisfy Sen. McClellan since it ignored many of the apparent discrepancies brought to light by the subcommittee. So the plan now is to let members of the source selection boards, which voted for Boeing, testify next. Then representatives of both General Dynamics-Grumman and Boeing will be called. After these witnesses have spotlighted the real points at issue, the subcommittee will call the service secretaries, including McNamara.

The key question, however, is what the hearings will accomplish. Senators participating in the hearings feel a subcommittee recommendation that the contract be canceled is among the possibilities. Sen. McClellan, for one, notes that contracts have been canceled before. And Sen. Edmund S. Muskie (D-Me.) goes further than that by declaring the subcommittee is morally obligated to recommend cancellation if the investigation "discloses beyond any reasonable doubt' that it was a mistake to award the contract to General Dynamics-Grumman.

Sen. Muskie concedes "it may be pretty hard to come up with the clear cut answer because so many of the decisions are subjective.' But he feels the subcommittee must persist in its effort to determine "which is the better plane for the purpose, present and potential. This is the heart of the matter. Unless you can prove that the right one was not selected, how can you raise questions about motives?"

At the other extreme of the possibilities is an endorsement of the award to General Dynamics-Grumman, along with recommendations that the procurement process be streamlined, especially in regard to evaluation groups—which in the F-111 contest numbered over 200 persons. A compromise predicted by one veteran senator is splitting of the contract between General Dynamics-Grumman and Boeing, even at this late date.

The key issue emerging is the so-called 'commonality' of the competing designs. McNamara in justifying his decision, contends that both finalists could have built the USAF-Navy tactical fighter specified, but that the General Dynamics-Grumman aircraft would be truly a bi-service one, whereas Boeing's proposal was more like two separate airplanes.

But the subcommittee is refusing to accept McNamara's word for it—an uncommon treatment for the persuasive defense secretary. The staff is prepared to argue the commonality question with technicians' figures and laymen's logic. The cross-examination will be the most severe challenge yet to McNamara's commonality concept.

If McNamara contends the objective of commonality is to save money, then the subcommittee will demand that the secretary rebut Air Force figures showing estimates that the Boeing proposal would have been cheaper.

In short, the F-111 investigation is not turning out to be Sen. McClellan vs. Vice President Lyndon B. Johnson, as was rumored before it began, nor General Dynamics-Grumman senators vs. Boeing senators. Instead, it is turning into the closest examination to date of the Defense Dept. procurement process.

Sylvester, Senators Clash on TFX Probe

Washington—Arthur Sylvester, assistant secretary of defense for public affairs, took an entire morning and 83 transcript pages in attempting to explain to the Senate investigations subcommittee what he meant by a few critical remarks about that group's investigation of the F-111 (TFX) contract.

Just before the hearing ended, Sen. Henry M. Jackson (D-Wash.) told Sylvester: "We could have saved virtually this whole morning's session if you had come in here and said, 'I erred. I made a mistake, and I am sorry.' That is all you would have needed to have said. You failed to do that. This is the reason you are having difficulty this time. This is why you have had trouble in the past."

At a press briefing Mar. 6, Sylvester said this about the TFX investigation: "You will hardly get a judicial rendering by a committee in which there are various senators with state self-interest in where the contract goes. So far, there is only one senator I have seen on the committee, Senator Muskie, who hasn't got an interest in it."

As the hearing began, Chairman John L. McClellan (D-Ark.) asked Sylvester what Arkansas stood to gain from the F-111 contract, which went to General Dynamics-Grumman after a final competition with Boeing. Sylvester replied: "You will notice in the transcript I made no reference to any senator, his fairness, no discussion of fairness, there isn't any word about anybody's being fair or unfair." He stressed his use of the word judicial, declaring he sought to distinguish the subcommittee from a court of law.

Questioning by Sen. Edmund S. Muskie (D-Me.) seemed to me to be in an effort to keep the thing so far as the Defense Dept. was concerned in a larger frame of reference,' Sylvester said in explaining his reference to him. Sen. Karl E. Mundt (R-S.D.), in asking Sylvester what benefit South Dakota could expect from the F-111 contract said: "I was shocked when I found that I was included among those who came from states which did have a self-interest. If you have got some secret information, don't withhold it." Sylvester replied: Unfortunately, I am not an expert in this field,' and then shifted the subject to the question of whether Sen. Mundt was prejudging the issue of which contractor should have won.

Sylvester said he knew of no F-111 contract or subcontract which involved South Dakota, Nebraska, New Hampshire, North Carolina or Maryland, the home states of other members of the subcommittee. Sen. Muskie quipped: 'I suppose I ought to defend myself here this morning. At the very least I ought to try to find out how I can get a piece of this contract in my state.'

The subcommittee members also challenged this statement by Sylvester at his Mar. 6 briefing: "I have read the testimony. It sounds to me as if I were reading the counsel for Boeing." Sen. Mundt said the witnesses to date had been from the Defense Dept. 'so I don't think you should attack us because the evidence they present has been up until now detrimental to General Dynamics and preferential to Boeing.'

Sen. Mundt then said he had read that Sylvester "believed that government has the inherent right to lie to the people." Sylvester denied he ever said that. Sen. Mundt said he hoped 'you don't carry it to the point that it would involve your testimony under oath to this committee.' Sylvester replied: "There is rather an insult implied in that. . . . The government does not have a right to lie to the people, but it does have a right in facing an enemy if information is not accurate and is intended to mislead the enemy. I think that any people will support their government in not putting out information that is going to help the enemy. And if necessary misleading them."

Sylvester also clashed with Sen. Jackson when, in explaining his remark about the Boeing Co. counsel writing the testimony, he said he meant "a contract has been let and an effort is being made by the disgruntled losers to knock the contract down." Jackson retorted: "Just get something clear, sir, the Boeing Co. never asked for this hearing. Do you understand that? I asked for it. They did not ask me." Sylvester denied he was implying Boeing instigated the subcommittee investigation.

"I think this all brings out something," Sen. Jackson said, "that you are a little careless with words. This is where you get in trouble. Mr. Sylvester. This isn't the first time." Sen. Muskie said: "I suppose I ought to consider it a compliment that my purity has been held up to public view, but this has been done in a way to cast discredit upon my colleagues and to the extent that it does I think it casts discredit on me because we have been a team now for these years. . . ."

ask the two finalists to rework their designs again. Gilpatric's July 13 letter to the contractors said these basic conditions had to be met: (1) Air Force and Navy must be satisfied that the winning design would give "a significant improvement" to their tactical air capabilities; (2) "minimum divergence from a common design, (3) demonstrably credible understanding of costs for both development and procurement of the complete TFX weapon system.' The new proposals were submitted in September.

• **Fourth evaluation.** McNamara said the evaluation group—a separate body which sent its recommendations to the source selection board—reported that both proposals met the conditions set forth in the Gilpatric letter. McNamara said that in this fourth competition, the evaluation group did not choose between contractors. "When I reviewed the report, I could see why. The question was a very close one."

McNamara quoted the evaluation group's report as declaring General Dynamics-Grumman had "a better structural design, a simpler fuel system, a slight edge in the flight control area and better proposed programs in the personnel subsystem and aerospace ground equipment areas. The General Dynamics design had an edge in supersonic dash capability and supersonic maneuverability at altitude. It has a low radar cross section and an integrated penetration aids system. For deceleration, it uses dive brakes in the air and brakes on the ground, providing a conventional but limited deceleration capability. The Boeing design has the edge in ferry capability, conventional weapon carriage, loiter capability, and in landing performance. It has the advantage in low-altitude maneuvering capability. For deceleration it uses a thrust reverser which offers an excellent deceleration capability, but will require additional development effort."

McNamara said that in the operational area, Boeing received the higher score, but the evaluation group report said that either design was acceptable from the users' viewpoint. In the production, management and cost' area, General Dynamics was rated higher than Boeing, McNamara said. "In scheduling, General Dynamics presented the better program," he said. "It was somewhat more detailed and better time-phased. In the logistics area, which includes the functional elements of maintenance, supply, transportation and procurement, the Boeing proposal received a slightly higher rating over-all," he said.

On Nov. 20, 1962 the source selection board unanimously recommended Boeing, according to earlier subcommittee testimony. McNamara said the board "understandably" would consider commonality and understanding of costs less important than operational capability, since the former 'are conditions

Lockheed XH-51A Rigid-Rotor Helicopter Flies

Lockheed California Co.'s XH-51A research helicopter, built under a joint Army-Navy contract, is shown during flight at Lockheed's Burbank, Calif. facility (AW Oct. 15, p. 23). Helicopter has a three-bladed rigid rotor system and is designed for speeds of 150 mph. and above. Helicopter also has retractable landing skids and all-stainless steel rotor blades. NASA has tested rotor at 184-mph. speed.

more properly the concern of those charged by law with the interest of three divisions of our defense effort." He said that as Secretary of Defense, he had to look upon those conditions from the point of view of what is in the national interest. McNamara said the General Dynamics-Grumman design was generally more straightforward in approach than that of Boeing.

He said these three elements of the Boeing proposal complicated the development of the aircraft use of thrust reversers for in-flight deceleration, even though they have not been proven on supersonic fighter aircraft placing air inlets on top of the fuselage, which might distort the air flow during high angle attack, and the extensive use of titanium in the wing structure. It appeared to me that Boeing simply did not appreciate the complexities of developing the F-IX and therefore was overly optimistic in its cost estimates," McNamara said.

McNamara said Gilpatric, Navy Secretary Fred Korth and Air Force Secretary Eugene M. Zuckert all agreed the contract should go to General Dynamics-Grumman and arrived at their decisions independently. "The award was announced Nov. 24, 1962.

With McNamara justifying his decision largely on the greater commonality in the General Dynamics-Grumman design, this point is bound to become a central issue in the subcommittee's investigation. Already the subcommittee is disputing Zuckert's Mar. 3 release, which cited commonality as one of the reasons for awarding the contract to General Dynamics-Grumman.

On a reasonably comparable basis, Zuckert said, 85% of the parts in the General Dynamics version are identical, contrasted with 60% in the Boeing proposal. This factor will become increasingly important as the development program of the aircraft evolves. Furthermore, it is doubtful that, in the normal course of development, Boeing can maintain their degree of commonality.

A chart of Defense Dept. figures prepared by the subcommittee shows that the percentage of identical parts to total parts was 83.6% for General Dynamics and 60.7% for Boeing, while the percentage of identical and similar parts to total parts was 85.2% for General Dynamics and 80.6% for Boeing. Another chart shows that Boeing would need less special tooling than General Dynamics to build its F-111.

Ben Gillens, of the Senate preparedness subcommittee staff, submitted a special report which will be used to challenge McNamara's commonality concept. 'Commonality for commonality's sake means little,' Gillens said. "Commonality has merits when it will achieve the financial savings without too great a sacrifice of performance of the plane for the operational missions and requirements of the Navy and Air Force."

New Lear Venture

Wichita — Lear Jet Corp. plans to enter the avionics market as a manufacturer of general aviation avionics equipment, ground and spaceborne spacecraft instrumentation and industrial electronic and electrical equipment.

Lear said that the avionics program would not be in violation of its non-competitive agreement with Lear Siegler, Inc.

A Lear Siegler official confirmed only that such an agreement exists (Feb. 19, 1962, p. 34).

William P. Lear, Sr., has established the Lear Electronics Div. of Lear Jet and said the company will manufacture general aviation directional and vertical gyros, aircraft autopilots, attitude indicators, and a complete line of inverters. Company has delivered to the Air Force a five-axis helicopter drone autopilot system.

Many of the general aviation instruments will be installed in the company's Lear Jet executive aircraft (Mar. 26, 1962, p. 78). Lear said, although other brands of equipment also will be used.

Company already has in operation an aircraft autopilot overhaul facility at Wichita Municipal Airport which is handling most major makes and models of general aviation autopilots.

Relay Turned Off, On

Washington — Relay communication satellite was turned off the night of Mar. 11 when the Radio Corp. of America-built satellite again showed signs of severe electrical power loss (AW Dec. 24, p. 24).

National Aeronautics and Space Administration commanded the satellite to resume operations at 10 p.m. EST Mar. 13 and telemetry signals indicated that both supply voltage and spacecraft temperature had returned to normal levels.

Space Agency Faces Possibility Of $500-Million Slash in Budget

By Alfred P. Ahlbrando

Washington—National Aeronautics and Space Administration faces a sizable budget cut—up to half a billion dollars—unless a new Soviet space spectacular changes the attitude of an economy-minded Congress.

Members of the House Science and Astronautics Committee have indicated in three weeks of posture and authorization hearings their intention to cut any 'fat' out of the $5.7-billion budget. Rep. J. Edgar Chenoweth (R-Colo.) has suggested a 10% cut and other members, Democrats as well as Republicans, have questioned the need for individual items.

At the same time, NASA Administrator James E. Webb has maintained rigorously that any significant cut will mean a delay in the nation's primary space goal—a manned landing on the moon before the end of this decade. President Kennedy told a press conference on Mar. 6 that to cut the space budget would be to make 'a determination that we are going to be permanently second-best in space.'

Lack of funding already has set back the Apollo and Gemini programs. Brainerd Holmes, director of NASA's Office of Manned Space Flight, told the House manned space flight subcommittee that the refusal of the Administration to ask for a supplemental appropriation last fall delayed these programs about five months.

Engine Demonstrations

Manned flight subcommittee, headed by Rep. Olin Teague (D-Tex.), last week visited the North American Aviation plant at Downey, Calif., where the Apollo spacecraft is being developed. saw two Rocketdyne F-1 engines fire for 150 sec. and 109 sec. at the Edwards, Calif., Rocket Test Center, and in speeded United Technology Center at Sunnyvale, Calif., where the solid strap-on boosters for the Titan 3 are being developed.

Rep. Teague said he was satisfied with the pace of Apollo development but was unable to get a clear picture of how funds were reprogramed for work connected with Apollo. He said the F-1 firings he saw were encouraging and some progress has been made in solving combustion instability problems.

Rep. Teague's subcommittee resumes hearings this week and will question witnesses on the lunar orbit rendezvous decision, progress in development of the Grumman Lunar Excursion Module, NASA-Air Force cooperation in manned space flight and NASA's contracts with Bellcomm, Inc., for systems engineering assistance and General Electric for checkout and integration on Apollo.

Dr. Homer E. Newell, director of the Office of Space Sciences, and his deputy, Edgar M. Cortright, told the House space sciences subcommittee that NASA would continue the Surveyor orbiter program. In earlier hearings before the full House space committee, Newell had disclosed the Surveyor orbiter program was under review (AW Mar. 4, p. 25) and the consideration was "whether it is best ... to have an orbiting Surveyor ... or ... to phase in the photographing of the moon and the visual observation of the moon into the manned program later."

In the authorization hearings before the space science subcommittee, Newell said some of the facts that influenced the decision to go ahead with the Surveyor orbiter were the need to map the surface of the moon as early as possible and the difficulty of adding a reconnaissance module to the Apollo system development program.

NASA plans a total of six Surveyor orbiters at a cost of about $150 million. The first orbiter flight is expected about mid-1964 and the agency hopes to get useful pictures from at least two of the six flights before 1967, when the first Apollo flight around the moon is scheduled. NASA is asking for $28.2 million in new obligational authority in Fiscal 1964 to begin work on Surveyor orbiter hardware.

Newell and Cortright also said NASA is considering modification of the Surveyor spacecraft for use as a possible moon roving science laboratory.

"We are now seriously engaged in a design study to upgrade the Surveyor to where it can carry a small rover weighing between 100 and 200 lb. which can cover miles from the spacecraft and provide photographic coverage as well as surface beaming tests,' Cortright said. They said no funds were being requested yet for hardware.

If the Surveyor rover becomes an approved program, it will be used to explore the illuminated side of the moon to a distance of 300 mi. on each side of the lunar equator.

Newell and Cortright also outlined for the subcommittee the following Surveyor lander development and flight schedule:

- **Final design changes** have been worked out on an engineering mockup and the main retro and vernier propulsion units developed and tested.
- **Landing tests,** using the retro motor, are to be made soon at Holloman AFB.
- **Test models** will be subjected to simulated lunar operations in the desert at Goldstone, Calif., this spring. Experiments on the spacecraft will be operated remotely by telemetered command, as they would be on the moon.
- **First two flights** of Surveyor in 1964 will be spacecraft tests. First Surveyor lander is scheduled for a full mission in the second quarter of 1965.

Cortright said NASA now plans 17 Surveyor lander flights and will fly five to seven Surveyors a year 'until they cease to pay off.'

Cost of developing and flying three Voyager planetary orbiter and lander spacecraft, the NASA officials said, would total about $300 million. NASA held a bidders briefing last week (AW Mar. 11, p. 302) on studies for three possible payloads. Bids are due May 25. If NASA asks for and receives monies for Voyager hardware development in Fiscal 1965, the first flight will be launched close to the end of the decade.

Ranger Improvements

Discussion of the Ranger review (AW Dec. 24, p. 17) in the subcommittee hearings disclosed that specific improvements incorporated in the next spacecraft, to be flown in December, include redundant circuits in the control computer and sequencer division of the six-camera television package into two independent systems of three cameras each and a capability for turning the spacecraft's gyros on and off.

Subcommittee members asked for a detailed evaluation of the performance of the Jet Propulsion Laboratory, which manages NASA's lunar and planetary programs. Newell and Cortright said the Kelly report, written following a review last fall of the Ranger program and classified secret, indicated that quality control at JPL was "spotty" and that the standard of performance was not uniform throughout the laboratory.

They defended the overall performance of JPL. They said management changes made following the failure of Ranger 5 and selection of the Northrop Corp. (see p. 26) to provide industrial support in the Ranger program (AW Feb. 25, p. 39; Mar. 4, p. 31) should solve problems noted in the report.

Subcommittee members asked for both classified and unclassified versions of the report. They directed that the classified version be called to the attention of the House Government Information subcommittee to determine whether classification was necessary.

Cortright said the report included information classified by the Air Force. He suggested that a comparison of the secret and unclassified versions by the House space subcommittee would show that no facts pertinent to JPL's performance were being withheld.

Defense May Ease Impact of X-20 Loss

By Edward H. Kolcum

Washington—Defense Dept. has made firm its decision to cut back severely or cancel the X-20 (Dyna-Soar) manned boost-glider program, but may do so gradually to ease the widespread political and technical impact.

Defense Secretary Robert S. McNamara, who last week visited X-20 and Gemini facilities, had told the House Armed Services Committee during military posture hearings earlier that "events appear to have overtaken Dyna-Soar, and that its future was in doubt." Testimony was released last week.

In his testimony, McNamara continually equated X-20 with the National Aeronautics and Space Administration's two-man Gemini spacecraft project. Although he said "there is no clear military requirement for either,' he left no question that the two programs are competing for development money, and that he favors Gemini because of its "greater military potential."

Gemini Agreement

Defense Dept. and NASA signed an agreement in January which makes USAF an active participant in the Gemini project (AW Jan. 28, p. 26). The degree of Air Force participation, and the financial support Defense Dept. will give Gemini, are still undecided. McNamara's X-20 testimony could be interpreted as a justification for Gemini funds, rather than X-20 money. Fiscal 1964 budget request for X-20 is $125 million. These were key statements in his testimony:

- **U. S. must decide** at some point which base—Gemini or X-20—it will cover. "At some point, we ought to give up covering two bases" before U. S. has committed itself to spending $1.6 billion for both.
- **Gemini is a competitive** development with X-20 because both provide low-earth orbit flight with controlled reentry. "Dyna-Soar does it one way, with flexibility, and Gemini another."
- **Gemini has a greater** military potential, "even though a rather ill-defined military potential," and it will be available sooner than the X-20. Air Force Secretary Eugene Zuckert said the first X-20 flight is now planned for November, 1965. First manned Gemini flight is scheduled about 18 months earlier.
- **X-20 has certain re-entry** advantages over Gemini, but "I seriously question whether our nation requires that both programs be completed." He said that although there is no clear military requirement for manned space flight, "I am very anxious ... to develop a capability to put a man in space for military purposes, should a requirement develop in the next few years. Therefore I am very anxious that we proceed with one or the other."

Aviation Week & Space Technology reported the probable cancellation or cutback of X-20 last month (AW Feb. 25, p. 26) and the relationship of the cutback to Gemini. Some key USAF officials protested that the situation was not that critical, and that Gemini and X-20 are not "either-or" projects. Although McNamara conceded that the two programs are not entirely comparable because of the different reentry techniques, he left little cause for optimism about the X-20's future.

McNamara visited NASA's Manned Spacecraft Center in Houston and the Boeing plant in Seattle in a 30-hr. round trip from Washington Mar. 13 and 14. He was accompanied by Zuckert, Dr. Harold Brown, director of defense research and engineering, Dr. Laurence Kavanau, special assistant to McNamara for space, Gen. Bernard A. Schriever, commander of Air Force Systems Command, Dr. Robert C. Seamans, Jr., associate NASA administrator, and Brig. Gen. George S. Brown, military assistant to McNamara. Briefing in Houston was conducted by Robert R. Gilruth, director; his deputies, Walter C. Williams and J. C. Elms; and James Chamberlin, Gemini project manager.

A factor that could complicate cancellation of X-20 is Boeing's role as prime contractor. Bitter feelings have arisen in Congress because of the award of the F-111 (TFX) contract to the General Dynamics-Grumman team after four military source selection boards had unanimously recommended that Boeing build the fighter (see p. 26).

A gradual cutback could be accomplished by reducing X-20 to a component feasibility program, much like the Aerospace Plane program now under way. In this manner, funding would be reduced significantly without the shock of an outright cancellation.

Another complication is the recent statements by NASA and Air Force leaders on the need for technology that X-20 will generate.

James E. Webb, NASA administrator recently said in Wichita that Dyna-Soar has been the vehicle considered most useful for studying high speed reentry with a maneuverable capability." Webb said Defense Dept. and Air Force are involved in deciding the future of the program, and he declined to discuss its continuance. He said, however, that X-20 re-entry features are quite important in advancing technical knowledge.

Webb had approached McNamara earlier with a plan for greater NASA participation in the program, particularly in funding. It is considered highly unlikely, in view of McNamara's testimony, that Congress would approve a NASA-managed X-20 program. The reasoning would probably be that if the technology is not worth $800 million to Defense Dept., it is not worth it to NASA.

Dr. Seamans also supported continuation of X-20 during House space committee posture hearings.

Strongest support for the program came before the same committee in testimony by Lt. Gen. James Ferguson, deputy USAF chief of staff for research and development. "I can assure you that the Air Force does, has and will stand up and fight for Dyna-Soar. We think it is a most critical part of the national space program," he said.

USAF Split

While Air Force speaks with a single public voice on the merits of X-20, the service is split on whether it can or should make it an issue in the face of impending budget cuts.

One faction is firm in its position that X-20 is so important that its funding should not be cut, and that Gemini is not a suitable alternative. Another faction agrees with McNamara: the program is valuable, but is not worth $800 million to obtain the maneuvering reentry and radiation-cooled structure technologies that will come of it. The latter group feels Air Force should give up X-20, shift the funds to Gemini and eventually conduct its own manned space flight program based on Gemini.

A splinter group supported by some members of both factions feels that if X-20 is canceled, the money should be diverted to a vastly-expanded hypersonic cruise vehicle program—the Aerospace Plane—which could establish X-20 technology and significantly advance the state of the art across the space technology spectrum.

The over-riding Air Force position, however, is to demonstrate that there is a military manned space flight mission. Air Force had hoped to get both X-20 and Gemini spacecraft to accomplish these demonstrations. The reasoning behind the position that Gemini is not a suitable X-20 replacement, in addition to its limited maneuvering flexibility, is the X-20's greater versatility. The X-20 would also have more room for equipment and men. It had been planned to increase the number of pilots to three, and to use the glider as a testbed for the reconnaissance and ferreting components.

British to Reorganize Fighter Command

By Herbert J. Coleman

London—Royal Air Force Fighter Command will be reorganized into three new control sectors, Secretary of State for Air Hugh Fraser told Parliament. Tied in with the reorganization will be the elimination of two units that distinguished themselves during the Battle of Britain—No. 11 and No. 12 Groups.

Fraser said the decision to reorganize Fighter Command tactics is related to a shift in emphasis from the manned bomber to the missile. The three new sectors will cover Scotland, the north and the east of England. Sectors, Fraser said, will be set up to handle day-to-day training and operations under control of a command headquarters.

Even though the threat has shifted from the manned bomber, Fighter Command will be needed to prevent reconnaissance and to deter and prevent jamming of the United Kingdom radar system, Fraser continued. For these tasks, the command will get advanced versions of the English Electric Lightning jet fighter, equipped with the de Havilland Red Top heat-seeking air-to-air missiles. In addition, new radars are being brought into operation for both military and civil control, in conjunction with the BMEWS site at Fylingdales which will become operational this summer.

Fraser said there will be no cutbacks in Bomber Command as the major nuclear deterrent, but he was subjected to some criticism regarding the so-called new strategic concept of the TSR.2 strike reconnaissance fighter now being built.

Fraser declined to reveal any details of the TSR.2, particularly when pressed for its eventual range, other than to say it would have a long range and the ability to operate from grass or semi-prepared surfaces. When reminded that in 1959 the airplane was described as a support weapon for the British army, and had now become a strategic weapon carrying a nuclear deterrent, Fraser retorted:

It is a very complex and advanced weapon with considerable versatility which includes both strategic and tactical capability."

In a pointed reference to one of the government's sharpest critics on defense policies, Fraser said: "I am sorry that the honorable member for Dudley [Mr. Wigg] is not present. The other day he suggested that the TSR.2 would not fly. I believe that it will be flying within the next 12 months.

I am sorry that the honorable gentleman is not present for other reasons. But, as a close student both of racing and of defense matters, he is perhaps—as I see racing is shortly beginning again—paying more attention to Ruff's guide to the turf than to AVIATION WEEK."

Fraser added that the TSR.2, combined with the Hawker P.1154 vertical takeoff and landing strike fighter for RAF and the Royal Navy, which will replace the Hawker Hunter and the de Havilland Sea Vixen, will enable Great Britain to maintain its NATO contribution and will be the backbone of Britain's tactical strike power in supporting ground forces in limited warfare.

Regarding RAF Coastal Command, now equipped with the Shackleton maritime reconnaissance bomber, Fraser said a "great deal of thought" has been given to its eventual replacement. Although the characteristics of the replacement can be easily defined, he explained, the matter of its electronic countermeasures equipment is more difficult to anticipate.

In a broader context, Fraser told the House that outside Europe, there will be:

- **Continuing need for British** fighters in the conventional interceptor role and this will remain in effect for many years.
- **Bloodhound Mark 2** will be used for anti-aircraft protection on all of Britain's main bases overseas, with the weapon entering service early next year.
- **Continued buildup** of Transport Command, with future emphasis on the VTOL tactical transport the Gloster Whitworth AW.681 (AW Mar. 11, p. 303). Fraser said that in the last 24 months, Transport Command has received 5 de Havilland Comet 4 jets, 30 Gloster Whitworth Argosy turboprops, and 20 Westland Whirlwind and 15 Belvedere helicopters.

In a discussion of the Royal Navy estimates, C. J. Orr-Ewing, the civil lord of the Admiralty, said Britain's Polaris program could initially involve construction of four submarines. Weapons would be purchased from the U.S. with the exception of the nuclear warheads and, possibly, the re-entry bodies.

Orr-Ewing said three British firms have been asked to bid on the submarine contracts—Vickers, Ltd., of Barrow; Cammell Laird, of Birkenhead, and Scotts Shipbuilding and Engineering of Greenock. The job will go to two of the three firms. Each will build two boats. Orr-Ewing indicated that Vickers will be selected as one firm because of its extensive experience in construction of nuclear submarines of the Dreadnought class.

Solar Flare Prediction Progress

Washington—Preliminary results from the X-ray ionization chamber experiment on the National Aeronautics and Space Administration's Orbiting Solar Observatory (OSO-1) indicate that solar physicists may be a step closer to their goal of predicting solar flares and also closer to understanding the basic mechanism which causes them.

OSO-1, which completed its first year in orbit without major failure on Mar. 7, has telemetered back X-ray data in the 1 to 10 Angstrom region which shows a clearly defined step-like progression in the intensity of a series of X-ray producing "microflares," William A. White, deputy head of Goddard Space Flight Center's Solar Physics Branch, told a session of NASA's Scientific Satellite Symposium here last week.

Microflares are flares too small to be observed telescopically from the earth, but which manifest their presence by a burst of X-rays, White said. They are associated with solar centers of activity, which can give rise to the visible major flares. Goddard scientists were able to construct straight lines through the peaks of as many as six consecutive microflares on an intensity vs. time plot.

The lines of different microflare groups have the property of possessing the same slope—that is, of making the same angle with the horizontal axis, regardless of whether they are ascending or descending in intensity. Moreover, the times of occurrence of the microflares seem to follow a geometric progression. The straight line joining the intensity peaks is defined as soon as two flares of the series have occurred. Taking the intercept of this line with the base (level of background X-ray intensity) as T = 0 (for an ascending series of microflares), then the time of the third microflare can be computed, since the ratio of the time of the second flare to the time of the first flare is equal to the ratio of the time of the third flare to the time of the second flare.

No final explanation for these properties of microflares has been formulated, White said, but they seem to point to some fundamental solar phenomenon having long term regularity and stability.

Photo sequence shows recent test firing of Army/Marine Corps Redeye surface-to-air defense missile from bazooka-type shoulder launcher. Missile is designed primarily for use against low flying tactical aircraft and possibly against tactical missiles.

First Photos Show Test Firing of Redeye Missile

Redeye under development by General Dynamics Pomona is 4 ft. long, 3 in. in diameter, weighs 20 lb. and has an infrared seeker which acquires and tracks target starting before launch from tube. Redeye is powered by Atlantic Research Corp. solid-propellant rocket motor which fires in two parts. First part ejects missile from launcher, second part ignites in air for boost to target. Retractable fins lie flat in launcher, pop out after discharge. Redeye has been tested against variety of aircraft and helicopter drones (AW Dec. 24, p. 19). West Germany has ordered Redeye missiles for that country's tactical air defense program (AW Feb. 4, p. 32).

First ASSET Launch Scheduled in August

By George Alexander

Cape Canaveral, Fla.—First delta wing ASSET re-entry test vehicle is scheduled for launch here in August, using a Thor IRBM as the launch vehicle.

Six gliders will be flown in the Air Force ASSET (aerothermodynamic-elastic structural systems test) program, including four thermodynamic and two thermoelastic models. Originally, the program called for seven gliders (AW Feb. 5, 1962, p. 50)—two thermodynamic, three structural and two thermoelastic models—but USAF decided to combine the test objectives of the thermodynamic and structural models in one group of four vehicles.

Thermodynamic models will provide data on temperatures, heat fluxes and pressure distributions on a lifting body during re-entry. Thermoelastic models will provide information on high speed bending moments and degradation of structures under high g-loads and heat stresses.

Both categories of models being built by McDonnell Aircraft Corp., will be 78.17 in. long, with a span of 54.88 in.

Thermodynamic models will weigh about 1,100 lb. and the elastic models about 1,200 lb.

Glider Construction

All six gliders will be of the same basic construction: zirconia nose cap, molybdenum nose skirt, molybdenum base or underbody, columbium fixed-flap (also referred to as the ramp by project personnel) and forward cone section and graphite leading edges. The entire vehicle will be coated with a ceramic substance to prevent oxidation of the refractory metals.

Thermodynamic models will be flown first. First dynamic model will be lifted to an altitude of approximately 175,000 ft. by a Douglas Aircraft Co. Thor. It then will re-enter at approximately 13,000 fps.

Lower surface of the glider will mount about 140 sensors to record temperature and pressure data.

Second, third and fourth thermodynamic models will be launched by a Thor plus a second stage. The latter stage will be basically a modified version of the National Aeronautics and Space Administration's Delta second stage and will be powered by an Aerojet-General AJ 10-118 liquid-propellant engine.

These vehicles will be flown to altitudes between 195,000 and 230,000 ft. and then will re-enter at approximately 18,000 fps.

Project officials expect temperatures of about 4,000F on the nose cap, 2,000F on the lower body and about 3,000F on the wing leading edges. Two of these four gliders will be flown at an angle of attack slightly greater than 30 deg. and the other two at a slightly lower angle. Down-range distance reached by these vehicles should be around 2,295 naut. mi., with the exception of the first ASSET glider, which should reach only about 800 naut. mi.

Fifth and sixth models will be thermoelastic vehicles and will be flown to altitudes of about 165,000 ft. by Thors only.

These ASSET gliders are undergoing final design, but a decision has been made to mount a movable flap on the aft end of the vehicle to reduce flutter during re-entry.

Range of these gliders will be about 800 naut. mi.

Attitude Control System

All six gliders will include an attitude control system, using hydrogen peroxide as fuel. Pitch, roll and yaw jets, ranging from 2 to 5 lb. thrust, will be mounted in the aft end of the vehicles.

They will not be used on the elastic models since flutter is planned in the flight profile.

Each model will carry a liquid automatic destruct system. The liquid explosive is Aerex developed by Aerojet.

Syncom Motor

Jet Propulsion Laboratory will build the orbital transfer motor for NASA Goddard Space Flight Center's advanced Syncom satellite, scheduled to be launched late in 1964. JPL will expand its in-house solid-propellant capability for the task by building a 150-gal. vertical mixer at Edwards AFB. Motor will weigh approximately 600 lb., develop a thrust as high as 7,000 lb., and impart a velocity increment of 6,100 fps. to the Hughes 500-lb. advanced Syncom payload to inject it into a true circular 22,300-mi. stationary orbit over the equator.

By comparison, Syncom 1 transfer motor built by Thiokol weighed about 75 lb., was programed to impart 4,850 fps. velocity increment to the 71-lb. satellite.

Review of advanced Syncom requirements may result in an increase of the satellite weight from 500 to 700 lb.

As presently projected, the advanced satellite will have 1,200 two-way telephone channels or four TV channels, or a combination of telephone and TV channels.

Liquid explosive will be mounted in the left wing of each glider so that the Air Force can plot a downrange trajectory close to the islands off the coast of Florida.

Should the ASSET glider lose control, the left wing would be automatically blown off and the vehicle would veer in that direction away from inhabited islands and out toward the ocean area.

Air Force wants the ASSET vehicles to fly as close as possible to their downrange Atlantic Missile Range tracking stations for telemetry reasons. Data will be transmitted on a real-time basis through the plasma sheath which surrounds any re-entering body. Thermodynamic vehicles will carry both an X-band and VHF transmitter; the elastic vehicles will carry only the VHF unit.

ASSET recovery system is being developed by Northrop Corp.'s Ventura Div. It will consist of an approximate 20-ft.-long canvas-treated sleeve with a 6-ft.-dia. sphere attached to one end.

Drogue chute will pull the entire assembly out from the rear of the glider, where ambient air will inflate the sleeve, which attaches to the aft end of the glider, and the sphere. Air trapped in the sphere will prevent the glider from sinking before recovery ships reach the impact area.

Rotating Crews

McDonnell is understood to be planning assignment of two rotating crews for the program, each consisting of about 20 engineers and technicians and each man with a particular sphere of competence.

First McDonnell crew will follow the first, third and fifth ASSET vehicles through manufacture, test and flight. Second crew will be responsible for the second, fourth and sixth gliders. Interval between launches if they are successful, is expected to be three to four months.

Thors to be used in the ASSET program were formerly emplaced as weapon systems in the United Kingdom. At present, it is unclear whether NASA will allow USAF to buy three AJ 10-118 engines off the Aerojet production line or whether they will have to be ordered as additional units. If the latter occurs, launch of the second ASSET glider—the first to be launched by the two-stage launch vehicle configuration—could be delayed until the engine could be made available.

Hughes LOH Shown in First Flight Photo

OH6A, Hughes Tool Co.'s entry in Army's competition for a light observation helicopter, has accumulated about five hours of flight time at speeds up to 85 mph. in the first three weeks of its flight test program. Maximum cruise speed of the aircraft, utilizing a 250 hp. Allison T63 gas turbine engine, is programed to exceed 140 mph. Evaluation of the OH6A by the Army, along with competing entries of Bell's OH4A and Hiller's OH5A (AW Mar. 11, p. 256), will begin late this year.

Early Formation of Comsat Staff Planned; Incorporators Confirmed

Washington—Communications Satellite Corp. plans to assemble a staff as rapidly as possible in order to transform the company into an effective going concern, Sam Harris, vice chairman of the 14 incorporators reported last week to the Senate Commerce Committee.

The recent selection of Leo D. Welch as chairman and chief executive officer and Joseph V. Charyk as president and chief operating officer paved the way (AW Mar. 4, p. 25). Welch's salary is $125,000 a year and Charyk's is $80,000, it was disclosed.

Harris and the 13 other incorporators, including Welch and Charyk, appeared before the committee in connection with Senate confirmation of their nominations. This was quickly and unanimously recommended by the committee.

Congressional concern expressed at the hearing was mainly over the extent to which the new private profit-making company will assume the financial burden of research and development in the communications satellite field. Several senators joined Sen. John O. Pastore (D.-R. I.) in voicing skepticism that National Aeronautics and Space Administration should continue substantial work that will profit the private investors of Communications Satellite Corp. (AW Feb. 25, p. 30).

Sen. Mike Monroney (D.-Okla.) noted that presumably these investors will include manufacturers who are also making profits under NASA contracts for communications satellite development. NASA's Fiscal 1964 budget earmarks $55 million for work in the communications satellite area.

Harris told the committee that financing of Communications Satellite Corp.'s research and development program has not yet been considered. He noted that the key decision confronting the incorporators is whether the company should establish its own capability or farm out contracts to other organizations.

He commented that "very substantial technical problems still must be solved before a technically and economically sound commercial satellite system can be launched. Accordingly, we would welcome any research by other private interests or the government, undertaken in pursuit of their own objectives, which would help to solve these critical problems."

Other Incorporators

In addition to Harris, a New York attorney, Charyk, former under secretary of the Air Force and Welch, who will leave his position as board chairman of Standard Oil of New Jersey Apr. 1, the incorporators are:

John T. Connor, president, Merck and Co.; George J. Feldman, attorney and director of Mastan Co.; Beardsley Graham, president, Splindletop Research Inc.; Edgar F. Kaiser, president, Kaiser Industries Corp.; David M. Kennedy, chairman, Continental Illinois National Bank & Trust Co.; George L. Killion, president, American President Lines; A. Byrne Litschert, Florida attorney; Leonard H. Marks and Bruce G. Sundlun, both Washington, D.C. attorneys; Leonard Woodcock, vice president, United Auto Workers, and Sidney Weinberg, of Goldman, Sachs and Co.

Charyk and Graham will direct the corporation's technical programs, Harris said.

India-USSR Engine

New Delhi—Government-owned Hindustan Aircraft factory will begin manufacture next year of a Soviet engine to be fitted into the Mark 2 version of its trainer aircraft HF-24. The Soviets are sending some engines this year for trial purposes.

Mark 1, the earlier version of HF-24, is fitted with the British Orpheus 703 engine. Hindustan Aircraft and Bristol Siddeley have had differences over the export of the Orpheus-fitted HF-24 aircraft to Southeast Asian countries and the firm has been looking for a suitable engine to replace the Orpheus.

The Indian government has also received an exclusive license to manufacture French gas turbine engines for the Alouette helicopters, to be built in India. Under this license India will have the right to sell the helicopters or engines in most Southeast Asia.

Motor Failure Dooms First TAT Launching

Los Angeles—First launch of USAF Space Systems Div's thrust-augmented Thor (TAT) booster, topped by an Agena D spacecraft with a Discoverer payload resulted in destruction of the vehicle recently at 145,000 ft. altitude by the range safety officer at the Vandenberg AFB launch site.

TAT configuration is designed to provide a substantial boost capability for space payloads and afford initial launch research data for the Titan 3 space booster (AW Nov. 26, p. 23). TAT is comprised of a Douglas Thor core surrounded by three strap-on Thiokol XM-33 Castor solid-propellant motors.

One of the solid motors did not ignite because of a failure in its electrical system circuitry. This resulted in an asymmetrical thrust vector and weight-distribution condition in the TAT vehicle initially compensated for to some extent by Thor guidance. Two of the XM-33s burned for about 40 sec. and were jettisoned at about 70 sec. after liftoff. The third XM-33, unburned, could not be jettisoned because the motor's dead electrical circuit could not trigger the event.

At 130 sec. after liftoff when the vehicle had reached 145,000 ft., the degree of deviation from the programed flight path prompted the decision to destruct.

However, the launch demonstrated the feasibility of the basic configuration of the liquid core vehicle complemented by strap-on solids.

Jettison of the solids had been deliberately delayed until 30 sec. after their programed burnout to ensure that separation would occur without a spinning motion that might result in collision with the Thor core. Separation of the two XM-33s was precise, and for the second launch of the TAT vehicle, the jettisoning of the solid motors may be programed only five seconds after burnout to minimize the period for carrying the dead weight of the burned motors.

Launch sequence for the TAT launch calls for the Thor to ignite first. When it develops sufficient thrust to lift the vehicle off the pad, a sensor triggers the ignition of the three solid strap-on motors, so that all four components of the vehicle booster system burn simultaneously.

Thrust of the Thor is approximately 170,000 lb. This is augmented by a thrust of about 160,000 lb. from the combined battery of three solid motors (about 53,300 lb. each). This provides 330,000 lb. total thrust for TAT, a capability approaching that of the standard Atlas launch vehicle, which develops about 390,000 lb. thrust.

Nuclear Blast Detection Satellite Flight Testing to Begin This Fall

By Katherine Johnsen

Washington—Flight testing of Vela Hotel satellites for the detection of nuclear explosions in outer space is scheduled to start this fall.

A series of five launches of two satellites each, in tandem, is planned. The shots will be timed to allow incorporation of improvements indicated by the previous launch.

The first set of flight instrumentation and payload equipment, developed by Sandia Corp. and the Los Alamos Scientific Laboratory, is now being delivered to Space Technology Laboratory, the spacecraft contractor. Aerospace Corp. is the systems manager.

$27.5-Million Budget

The program has a $27.5 million budget for Fiscal 1964. It has been allocated a total of $49 million since early 1961, when design work began, through Fiscal 1963 (AW Aug. 7, 1961, p. 33).

Representatives of Advanced Research Projects Agency, which has cognizance of Vela Hotel, were optimistic in a report to the Joint Atomic Energy Committee that an operational system with a very high probability of detection and identification could be achieved and at a cost substantially lower than formerly estimated.

Dr. Alois W. Schardt, deputy director of ARPA's nuclear test detection office, said that the previous estimate of $100 million a year operational cost would eventually be lowered to $20 to $30 million a year. He estimated the construction cost, including launching pads and telemetry installations, at $300 million.

Dr. Schardt gave these reasons for the cost reduction:

- **Vela Hotel** will take advantage of the longer lifetime in orbit being established for commercial satellites and the continuing improvement in the ratio of launch successes to failures.
- **Ground-based detection** techniques are proving reliable in detecting tests conducted in "earth-moon space." This means that a satellite system would be required to cover primarily only deep space and fewer than six satellites would be required.

Air Force Maj. John A. Poulson, chief of ARPA's Vela Hotel branch, told the congressional committee that piggyback flights of equipment and information obtained during high altitude tests have corroborated estimates "and increase our confidence that the instrumentation under development can be reduced to practice through straightforward engineering effort."

Major Objective

A major objective of this year's flight tests is to obtain data on outer space natural phenomenon which can give a "false alarm" of a nuclear detonation.

The Vela Hotel spacecraft, costing an estimated $350,000, is a regular polyhedron with 20 equilateral triangular surfaces relatively easy to fabricate. X-ray detectors are located at the vertices. Solar cells for the power supply cover the triangular surfaces.

Two spacecraft will be enclosed within a glass-fiber radio frequency transparent nose fairing split lengthwise into a two-section clamshell to facilitate jettisoning.

For the first two weeks in orbit, each spacecraft will be tracked and the telemetry transmission recorded continuously in real time. After initial data demands have been met, the requirement for continuous real-time data will be relaxed. The electric logics associated with the payload will perform a screening process and only the most significant of the real time data will be stored in the memory system for periodic read-out.

Air Force is now in the process of establishing an orbital control and data acquisition station on one of the islands of the Seychelles group in the Indian Ocean to assure maximum information on solar flares from the satellites. National Aeronautics and Space Administration is also participating in monitoring the Vela Hotel satellites to obtain data on solar emanations for the Apollo program.

Detector Types

Each spacecraft will contain three types of detectors: ten X-ray detectors, six gamma-ray detectors, and a two-element neutron detector. Primary emphasis is on the X-ray instrumentation, since most of the energy in a nuclear explosion is in the X-rays, giving X-ray detectors a very long-range capability. Less than one-thousandth is contained in the gamma-ray and neutron radiations.

Dr. James H. Coon of Los Alamos Scientific Laboratory estimated a possibility of detecting a 10 kiloton explosion at a distance equal to the diameter of the earth's orbit around the sun with X-ray detectors. For lesser distances, the gamma-ray and neutron detectors would provide a redundant capability.

Individual R&D Productivity Is Declining

By Larry Booda

Washington—Productivity of U.S. research and development scientists and engineers is decreasing when measured by the money spent in these categories, according to John H. Rubel, assistant secretary of defense for research and engineering.

In line with this trend, he said last week, he has made private surveys which show that as engineering organizations grow in size, the number of technical papers and patents that are created declines dramatically on a per capita basis.

Rubel showed figures indicating that the cost of research and development for each technical man has been increasing since shortly after World War 2. This trend is a consequence of increased government expenditures for research and development, he told a two-day symposium of the National Security Industrial Assn. here.

Federal participation in research and development has grown to 75% of all money spent for this purpose in the U.S., he said. The federal share increased from about half of the total $1 billion spent in 1941 to $1 billion of the $15 billion spent in 1945, to $18 billion out of $24.5 billion in 1950, $4 billion out of $6 billion in 1955 and $9.2 billion out of $14 billion in 1960.

Federal expenditures for research and development have grown an average of 10% per year over the past 10 years, he said, but the growth since 1958 has been much more rapid than that. During this period government appropriations have increased by $6 billion, doubling federal support for research and development.

Until 1958, the Defense Dept. expenditures in these categories, including money spent by the Atomic Energy Commission and other defense-related activities, amounted to 90% of all federal outlays for research and development. But since then, Rubel pointed out, the large growth of the National Aeronautics and Space Administration budget has reduced the Defense Dept. share to 60%. The Defense Dept. share in dollars, however, increased more than $2.5 billion between 1958 and 1964—a 50% increase.

Rubel pointed out that the shift in emphasis from private to public support is accompanied by corresponding shifts in the character and distribution of that support among industrial concerns. Industry performs 80% of the federally supported work, while government activities account for 15%, and non-profit institutions 2%.

Government research and development expenditures for aircraft, missiles and space activities, and electrical equipment amount to 83% of the total. If motor vehicles, machinery and chemicals are added, the figure rises to 94%.

Four companies account for 29% of the government research and development spending, and the first eight account for 41%. Forty companies handle 86% of the business. In private-financed research and development, the 41% is spread over 40 companies and 200 firms account for 80%.

Rubel also explained that the rise in the number of personnel capable of performing research and development work is only 7% per year. If the appropriations rise faster than that, he added, the cost per technical man is bound to rise, but not necessarily his productivity. In fact, he said, no matter what type of index is used, the "cost per technical man-year" goes up.

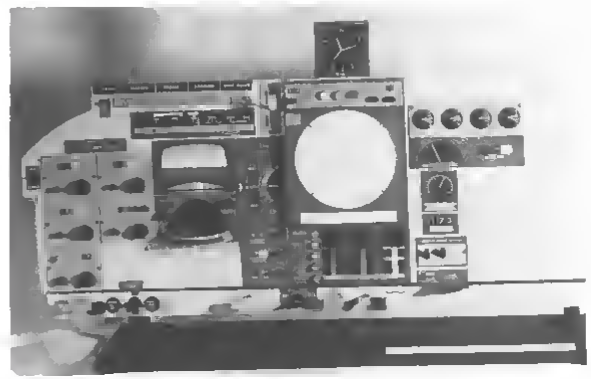
If this rise were to stimulate undergraduate and graduate enrollments, he said, it could be justified. But there is no evidence that the rising costs for scientific and engineering work has affected college enrollments, he said. Those enrollments reached about one million in 1960. Although they have increased in number, the percentage to the entire population remains the same. The number of scientists and engineers has doubled approximately every 12 years since 1900.

Rubel attributed industrial growth in five areas to research and development spending. They are:

- **Productivity.** Automation has caused rapid rises in industrial production rates. Scientific factory management has also contributed.
- **New products.** Television, pyroceramic materials, nuclear-powered submarines and ships and rocket engines are in this category.
- **New technologies.** Transistors, etched circuits for electronics, masers, infrared detection and propagation and radar were cited.
- **New techniques.** Systems engineering and operations analysis (such as PERT management techniques) are representative.
- **New industries.** Data processing, electronics and solid propellants were mentioned.

Rubel acknowledged that the bulk of original thinking and the facilities for accomplishing research and development come from industry, regardless of the source of funds. Without the help of industry, the revolutionary developments in weapons would not have been possible, he said.

He said that NSIA could be of help in improving utilization of manpower resources, the application of new knowledge and techniques on a broader scale and improving communications between the government and privately supported segments of the research and development effort.



First Project Little Guy Cockpit Mockup Shown

Prototype light aircraft cockpit developed by Federal Aviation Agency as part of Project Little Guy has large pictorial navigation display in the center with linear engine gages, airspeed indicator and altimeter. Heading indicator is a circular device in a horizontal plane. Cockpit will be tested in light aircraft simulator at National Aviation Facilities Experimental Center, Atlantic City (AW Feb. 18, p. 115).

LeMay Sees Offensive Space Force Need

Washington—Soviet Union's space program "is entirely military" and it soon will be necessary for the U. S. to respond to this threat by developing offensive as well as defensive space vehicles, Gen. Curtis E. LeMay, Air Force chief of staff, told Congress in hearings released last week.

Gen. LeMay said it was not foreseeable just when offensive military space systems would be needed. But he said: "I am sure they will come." By contrast, civilian leaders in the Defense Dept. have been skeptical that offensive space weapons ever will prove as practical as earth-based ones (AW Sept. 10, p. 25). Their main interest so far has been in military communication and reconnaissance satellites and defensive systems such as satellite interceptors.

After declaring that "it is my personal belief that the Russian space program is entirely military," Gen. LeMay told the House Armed Services Committee:

"We can't really define an offensive weapon for use in space that will be more efficient and less costly than one we could do the same job with on the ground or in the air. I do think that we have to get up there and find out what the situation is, and then these will come along. The weather system, the space tracking, the warning systems and things of that sort are a little clearer to us with the state of the art being what it is right now. Therefore we can go for those things.

"But on the offensive side of the picture, it is still pretty hazy. But I am sure they will come. And we are interested in them." He said the Air Force's five-year program "will lead toward these articles."

Gen. LeMay said the U. S. is at about the same stage in space science that it had reached in aeronautics in 1912. "No one then," he said, "could foresee the transportation systems that would evolve from the crude airplane we had at that time, or the weapon systems that have evolved from it or the change in all of our lives that aeronautics has brought about.

"We are in the same position as far as space is concerned now. We just can't define it accurately. The only thing I know is that we are going out there, and I am sure there are going to be military chores for us to perform out there if we are going to protect our rights and maintain peace in that environment."

Defense Secretary Robert S. McNamara said during the same hearings that Defense Dept. is studying military space systems. "At the present time," he said, "we see no advantage to space-based systems compared to surface of the earth or atmosphere of the earth based systems."

Other highlights of the House Armed Services Committee testimony:

- **Advanced aircraft.** Gen. LeMay said that although he has not been able to convince McNamara or the President of the continued need for manned bombers, studies were proceeding on several advanced types of aircraft (see box, p. 39).

"I have spent a lot of time trying to convince the Secretary of Defense on the subject of manned bombers," Gen. LeMay said. "I have not been able to convince him or the President. I think I have convinced a lot of other people but they make the decisions. And I have no other choice except to be a good soldier and carry them out and that is what I am doing."

Gen. LeMay said the Aerospace Plane may well be the successor to the USAF-North American RS-70, but he held out little hope for early development of a nuclear powered aircraft. "We have not lost all faith in atomic power," Gen. LeMay said, "but as far as we can see now" nuclear powerplants are not competitive with chemical fuels. Air Force is studying a long endurance subsonic aircraft and an aircraft designed for low altitude penetration.

- **Soviet Tu-95 Bear.** McNamara said it "is absolute baloney" to call this the best bomber in the world, as was done recently on a television program. He said the Bear has an unrefueled range of 7,800 mi. carrying a 25,000-lb. bomb load vs. 8,900 mi. for the Boeing B-52. The Bear has a maximum speed over the target of 435 kt. at its optimum bombing altitude of 41,000 ft., whereas the B-52 with the same bomb load has a speed of 467 kt. over the target at its optimum bombing altitude of 46,000 ft., McNamara said. He said the U. S. also has "far greater refueling capabilities," and said "... it is interesting to me how very limited a manned bomber capability the Soviets actually possess."
- **Solid vs. liquid rockets.** McNamara said he was "completely persuaded of the advantages of solid fuel missiles in the category of Minuteman and Polaris" and "I lean toward" solid fuel for USAF Martin Titan 3 class boosters. "I think it is fair to say the development of solid fueled launchers with rated capacities equivalent to that of Titan 3—that is to say a capacity or capability of putting roughly 25,000 lb. into a low earth orbit—is a technology that has not been fully developed."
- **Tactical aircraft alternatives.** "The Soviet air defenses of a Hawk (low level missile) type may so expand and improve as to seriously reduce the efficiency of our tactical aircraft, and we must think, therefore, of alternative weapon systems to replace the tactical aircraft should the Soviet air defenses increase in efficiency," McNamara said. This increased capability, he said, dictates greater emphasis by the U. S. on surface-to-surface tactical missiles.

Extra RS-70, Submarine Money Included in Defense Authorization

Washington—Kennedy Administration's new military budget passed its first congressional floor test last week when the House authorized more than requested for aircraft, missiles and ships in order to finance additional RS-70 bombers and nuclear-powered attack submarines.

House added $134,000,000 to the $12,229,500,000 requested for procurement and $363,700,000 to the $3,129,191,000 requested for research and development. All told, the House authorized $15,856,391,000 for procurement and research in Fiscal 1964 for aircraft, missiles and ships.

Increases voted by the House show continuing concern about the life of the manned bomber and the threat posed by Soviet nuclear-powered submarines. House Armed Services Committee sent the bill to the floor with a recommendation to build five Air Force-North American RS-70s rather than the three planned by the Administration. The additional two RS-70s would be equipped with a full weapons system so the aircraft could be tested as combat items rather than primarily as airframes.

The committee said it would cost $1.2 billion additional to build the extra two RS-70s, or $2.5 billion for all five. "The RS-70 program should proceed to the point where the feasibility of the RS-70 as a weapons system has been proved or disproved," the committee said in its report. "Manned strategic systems must continue to play a major role in our military capabilities." The committee said unless a follow-on bomber is developed now "we will today sow the seeds which will produce our strategic bomber gap in the late 1960's."

The Joint Chiefs of Staff in September, 1962, unanimously recommended developing the RS-70, the committee said. After Army Gen. Maxwell D. Taylor became JCS chairman and Gen. Earle G. Wheeler became Army chief of the Joint Chiefs on Oct. 1, another vote was taken on the RS-70 program. The committee said everyone but Gen. Taylor "supported the development of the RS-70 at a substantially higher level of development than that currently planned under the program of the Secretary of Defense. Under any fair interpretation, the best military judgment available supports the development program proposed by the committee."

The committee recommended authorizing the Air Force to spend an additional $363,700,000 in Fiscal 1964 to expand the RS-70 program. Five Democratic members of the committee dissented: Reps. Samuel S. Stratton (N. Y.), Jeffery Cohelan (Calif.), Otis G. Pike (N. Y.), Richard H. Ichord (Mo.), Lucien N. Nedzi (Mich.).

"Unless the manned strategic bomber can accomplish something important and essential [illegible] can do it [illegible] tively," they said, "there [illegible] obligation on the Congress [illegible] to produce the manned strategic [illegible] than there is to continue the [illegible] ship or horse cavalry. . . . Whether we like it or not, time and technology are clearly in the process of overtaking the manned strategic bomber as the keystone of our nuclear deterrent force. The highly sophisticated electronic gear which is essential to make the RS-70 system a reality appears to be as far away today as it was last year."

The additional $134 million added to the procurement account would cover the cost of starting construction on two more nuclear-powered attack submarines. This would make a total of eight such submarines authorized for Fiscal 1964, the number requested by the Navy when it submitted its budget to Defense Secretary Robert S. McNamara. "Our ability to contain and defeat that [Soviet] threat will depend on our sea power and its ability to protect our sea lanes and to deny portions of the sea to the Soviets," the committee said in recommending the addition. "The primary threat to our sea power is the Russian submarine."

Future Aircraft Studies

Washington—Air Force studies of future aircraft are focusing on three new types—a long-endurance vehicle, a low altitude bomber and a high-altitude bomber about half the size of the North American RS-70.

Gen. Curtis E. LeMay, Air Force chief of staff, told Congress in hearings released last week that these studies possibly could extend the life of the manned bomber beyond the RS-70. The long endurance subsonic bomber could serve as an aerial command post, ballistic missile carrier, long-range air-to-air missile launcher or electronic intelligence and electronic countermeasures aircraft. Studies are being carried out under the project name Dromedary (AW Feb. 18, p. 40).

The low-altitude aircraft would be designed specifically to achieve maximum penetration, thus demanding both high speed and heavy armament. The third bomber being studied would be a high-altitude type similar to the RS-70 "but using the state of the art that has advanced in the last four or five years since we started the B-70," Gen. LeMay said.

Bug Negotiations

Washington—Grumman Aircraft Engineering Corp. and National Aeronautics and Space Administration last week completed negotiations for production of the Lunar Excursion Module, which will carry two pilots to the lunar surface from the Apollo command module. Cost-plus-fixed-fee contract is valued at $387.9 million, and calls for production of nine development and 11 flight modules.

U. S., France Agree On Joint Space Effort

Washington—U. S. and France have agreed on a two-part space program designed to study very low frequency wave propagation. In another move U. S. and Australia agreed on the location of three new tracking stations in that country.

Agreement with France calls for launch of two French payloads by U. S. Aerojet Aerobee 150A rockets in Phase 1, and launch of a French satellite by a Scout rocket in Phase 2. Rocket payloads will measure electric and magnetic field strengths between the altitudes of 46-62 mi. The satellite will be launched into a low circular orbit. All launches will be from Wallops Station, Va.

The program with Australia involves a new deep space tracking station 11 mi. southwest of Canberra, a combination manned flight-scientific tracking station at Carnarvon and a similar station at Darwin.

Sergeant Deployment In Europe Scheduled

Washington—Sergeant surface-to-surface ballistic missile battalions will be deployed to Europe beginning this month, the Army said last week. Sergeant is a field artillery ballistic missile with a range of 25 to 75 naut. mi.

The Sergeant units will replace those [illegible] the Corporal liquid-fueled missile which has been operational for six years.

Sergeant is a single stage solid propellant missile weighing 10,000 lb., capable of carrying conventional or nuclear warheads. The system is mobile and air transportable.

The prime contractor is Sperry Utah, which took over from the original prime contractor, Jet Propulsion Laboratories, in July 1960.

News Digest

North American Aviation-Columbus Redhead Roadrunner target missile made its first supersonic flight Mar. 7 at White Sands Missile Range, N. M. Flight, in Redhead (high-altitude) configuration, attained 10,000 ft. altitude and Mach 1.3 speed. Missile descended safely by parachute/retrorocket system for re-use.

First deliveries of Apollo ground support equipment have been made by North American Aviation's newly activated Tulsa, Okla., facility to company's Space & Information Systems Div., Downey, Calif. NAA Tulsa also is designing and fabricating Saturn 5 S-2 booster ground support equipment and structural components, including the thrust structure.

Thomas F. Dixon has resigned as deputy associate administrator of NASA and has returned to North American Aviation, Inc., as assistant to the president, J. L. Atwood.

Two Bell 204Bs have been sold to the Indonesian government by Bell Helicopter Co. The two helicopters will be rushed to Indonesia by the Military Air Transport Service as they come off the production line. First will leave Ft. Worth by air Apr. 22, the second on May 10. They are for the personal use of Indonesian President Sukarno.

Navy Solar Radiation 1 satellite was turned back on by command Feb. 25 after orbiting in silence for 22 months. The 42-lb. satellite immediately began to transmit telemetry readout that showed there were no signs of deterioration in the vehicle's ability to perform its basic mission, proving that it had withstood high radiation bombardments.

Retired USAF Lt. Gen. Roger M. Ramey, 57, former commander of the Fifth and Eighth Air Forces, died Mar. 11 in Torrance, Calif. He had served as a corporate vice president of Northrop Aircraft, Inc., since his retirement in 1957.

British Carriers to Form Jamaican Airline

Island government wants to use leased aircraft; air fare reduction is sought to stimulate vacation travel.

By James R. Ashlock

New York—Jamaican government has selected British Overseas Airways Corp. (BOAC) and British West Indian Airways, Ltd. (BWIA) to establish a national airline for the Caribbean island.

Move is the first step toward readjustment of Caribbean air service in conformance with the recent ascension to independence by both Jamaica and Trinidad. The new airline is expected to be called Air Jamaica and will operate with leased aircraft carrying Jamaican markings.

BOAC and BWIA were selected from among eight airlines considered by a subcommittee of Jamaica's Air Services and Airline Policy Committee. Carriers considered, besides BOAC and BWIA, were Pan American World Airways, Trans-Canada Airlines, Guest Aeroviias Mexico, Trans Caribbean Airways, Irish International Airlines and Cunard Eagle Airways.

"The government will own the controlling interest in the airline," a Jamaican government statement said. BOAC and BWIA will acquire minority shares of the capital.

Final details of these and other arrangements for joint collaboration are now being discussed with these carriers by the government and will be the subject of a formal agreement," the statement noted.

Large Carrier

Government said BOAC and BWIA best fit the criterion it had set—a large carrier with world-wide connections, preferably already operating on the major routes in which Jamaica is interested and which would give the country maximum service and promotion abroad.

Jamaica is presently not interested in buying aircraft to establish a flag carrier, officials said, but prefers to use leased equipment. BWIA is already leasing Boeing 707s from BOAC for Caribbean service.

BWIA is also important to the collaboration because of its established rights into Trinidad. BWIA's participation will bring the long-sought establishment of non-stop service between Jamaica and Trinidad, terminal points of the Caribbean island chain.

New carrier will negotiate bilateral routes into New York and Miami, which it stands to receive from the Civil Aeronautics Board because of Pan American's rights into Jamaica from these points.

It will also seek service into Toronto in exchange for Trans-Canada's Jamaican routes.

BOAC officials said that the venture will require no subsidy support from the United Kingdom. The airline will be a wholly Jamaican enterprise managed by a chairman appointed by the government. The government will retain majority representation on the board of directors.

No Financial Realignment

BOAC also stressed that the arrangement does not constitute a financial realignment with BWIA. The two carriers parted company months ago, with BOAC maintaining only a 10% interest in BWIA and remaining stock in the airline being purchased by Trinidad and Barbados. BWIA's severance from BOAC came amid complaints from Sir Matthew Slattery, BOAC chairman, that his airline could not continue the support of associated companies with perennial losses like those sustained by BWIA.

Although both carriers will participate in the various responsibilities involved in the Jamaican airline, BOAC will probably assume the task of supplying leased aircraft while BWIA will concentrate more on operations. Jamaican citizens will be employed to the maximum possible extent, officials said, and will be offered opportunities for training in specialist fields.

Carrier's role in relation to the International Air Transport Assn. fare structure is a matter of speculation among some sources. Within Jamaica, opinions are strong that air fares into the island, particularly from the U. S., should be lowered to stimulate tourism. This would conform with the government's announced intention to reduce the cost of tourist accommodations on the island. It is aiming for a doubling of tourist volumes within the next five years.

Banking and hotel interests in Jamaica have long felt that the $225 air fare from New York to Jamaica is unrealistic in view of the $156 ticket available to travelers between New York and Puerto Rico. Influential parties in Jamaica have maintained that establishment of a national airline must be accompanied by a downward adjustment on air fares.

"The job that has to be done is essentially a team effort," BOAC officials said in commenting on the new airline, "and the most urgent need facing the team is the introduction of enlightened pricing policies."

BOAC said the reduction of tourist expenses in Jamaica is a vital item in attracting more vacationers to the island, "for lower air fares cannot alone achieve the substantial increase in visitors we all want to see."

Government said it will initiate special programs aimed at reducing the total price of a holiday in Jamaica.

"This can be achieved only by a general reduction of the charges paid by the visitor, particularly for his flight to the island, for hotel accommodation and for ground transport," government officials said. "BOAC and BWIA have readily agreed that the necessary support of other governments and carriers should be sought for lower promotional air fares."

17 Air Strips

Jamaica currently has 17 air strips, ranging in size from small crop-duster runways to the modern jetports at Kingston and Montego Bay. The government is also rushing completion of another jet-size airport at Port Antonio, a major tourist area on the northeast corner of the island.

Jamaican government is also considering establishment of an airline service to operate within the island. Researchers have estimated that a potential of about 250 passengers daily is available for a scheduled intra-island service, growing to over 400 daily inside of five years.

Trans-Caribbean and Guest are among those interested in the domestic operation, which the government has continually maintained must be operated separately from Jamaica's international airline. Although about 40 applications for the domestic service have been submitted in the past, almost all were discouraged by the government's refusal to support the operation with subsidy.

First Japanese-Built Vertol 107-2 Delivered

First Japanese produced Vertol 107-2 twin turbine helicopter was delivered to Kanki Airlines of Japan recently. The helicopters are manufactured under license agreement by Kawasaki Aircraft Co. Kanki will inaugurate service in the Kyushu region south of Tokyo. Primary purpose of the 107s will be to transport construction materials to dam sites. Shinto ceremony was observed.

ALPA Threatens to Expel 4 at American

New York—Air Line Pilots Assn. has threatened to expel four American Air Lines captains involved in negotiating a new contract for American's 1,850 pilots and 600 flight engineers (AW Feb. 25, p. 42).

Expulsion petition, signed by ALPA President Charles Ruby and endorsed by the union's nine-member executive committee, has been submitted to the three-man hearing board of the union. The charges are that the American pilots are pressing for a contract with provisions contrary to ALPA's requirements on cockpit crew standards.

"We could carry it to the ALPA appeals group if the hearing board expels us," said Nicholas J. O'Connell, head of the American negotiating team. "But things have reached such a state that I see little point in doing so."

O'Connell and others at American are sticking by their contract proposal which the company has said is acceptable. It provides for a reduction in jet crews from four to three men with the flight engineer being trained to assist the pilots in radio work and navigation. However, he would not be trained as a pilot with commercial and instrument ratings, as have the flight engineers of other carriers at costs exceeding $10 million.

In return for eliminating this expense, the company has agreed to certain concessions for flight crews, primarily a reduction in monthly flight time requirements from 85 to 75 hr. on jets.

Commercial and instrument ratings for the flight engineer are mandatory in ALPA's three-man jet crew standards, which were included in contracts signed with Trans World Airlines, Eastern Air Lines and National Airlines.

ALPA has filed for an injunction against American, maintaining that the union is the authorized bargaining body for the carrier's pilots and that the contract is unacceptable.

Preliminary hearings on the injunction are scheduled tomorrow in the U.S. District Court here. O'Connell has also called a meeting for tomorrow here of the 22 local chairmen and senior copilots representing American's ALPA members in 11 stations. He said they would discuss ratification of the contract by American's crews, and also the ALPA expulsion move.

"The master executive councilmen have told me that they are 100% in support of the contract," O'Connell said.

One member of the negotiation group, Capt. Harold Miller of Dallas, has resigned. Miller said he found no basic fault with the contract other than it did not comply with ALPA's standards. However, this was sufficient grounds for dropping his support of the pact, he said.

There has been growing evidence among American crews of dissatisfaction with ALPA. Many feel that the union has become dominated by factions and "political" influences.

United Air Lines pilots, who have the largest membership on the executive committee, are a frequent target of criticism. United's influence in ALPA became strong following the merger of its crews with those of the former Capital Airlines.

"United's pilots have been against us all the way," one American pilot complained. "Many of us think they simply don't want us to bring our 600 engineers into ALPA and cut into United's membership advantage."

O'Connell, in a letter to American's crews reporting on progress of the contract talks and telling of the expulsion threat, also blamed United's influence on the executive committee for many problems.

Some are interpreting the expulsion move as a warning to all American pilots not to support the contract. However, Ruby said earlier that the union had no desire to expel all of American's pilots, and asked them to reconsider their support of the proposed contract (AW Mar. 4, p. 35).

American's flight engineers have also expressed some uncertainty on the contract because of the feud with ALPA, and have asked for intervention by the AFL-CIO, parent organization of both ALPA and the Flight Engineers International Assn.

Meeting in Los Angeles, the flight engineers petitioned George Meany, head of the AFL-CIO, to make a statement that might help settle the dispute between the American pilots and ALPA. However, after two weeks, Meany had made no statement.

The flight engineers are naturally reluctant to sign the American contract if ALPA, to which they had originally planned to shift their membership, expels the American pilots and engineers. This would leave the engineers without union representation.

Newest jet in the air

The Boeing 727's historic first flight took place February 9. After the flight, Boeing senior experimental test pilot, Lew Wallick, reported: "The 727's performance exceeded all expectations. Her response to controls is instantaneous and effortless. Pilots are really going to like this one."

Performance has been so troublefree that the initial phase of flight testing, involving more than 16 hours, was completed far ahead of schedule. Test programs originally planned for April were begun late in February, a record that documents the extraordinary built-in reliability of the 727.

The three-jet 727, shown above taking off on a test flight, is an extremely versatile aircraft, able to serve profitably over routes ranging from 150 to 1700 miles. It can operate from 5000-foot runways, and carry from 70 to 114 passengers at speeds up to 600 mph. Its cabin is as wide as that of the 707 and 720, an advantage that assures maximum profit on high-density routes. In addition, the 727's low operating cost per airplane mile assures profitable operation even over low density routes.

After one of the most intensive test programs in airliner history, the 727 will go into service early next year. Already, 131 Boeing 727s have been ordered by American, Ansett-ANA, Eastern, Lufthansa, TWA, Trans-Australia and United airlines.

BOEING 727

SST Simulator to Aid Traffic Study

Washington—Federal Aviation Agency and the National Aeronautics and Space Administration will begin a joint study of supersonic transport traffic patterns in May, using a flight simulator under construction for NASA's Langley Research Center.

Four supersonic transport configurations, developed by NASA will be employed in the study involving simulation of today's traffic patterns and those expected in the 1970s.

During initial stages of the program, traffic data will be collected from FAA's National Aviation Facilities Experimental Center (NAFEC), Atlantic City, N. J., for later use with the supersonic transport flight simulator being constructed for the Langley Center at Hampton, Va. Cost of the simulator is $919,000 with NASA providing $669,000 and FAA $250,000. It is being manufactured by the Electronics Div. of the Curtiss Wright Corp., East Paterson, N. J., and is expected to be completed by October.

The simulator will have a cockpit similar to that of today's subsonic transports. It will have room for a four man crew, a communications system and instrumentation for the higher speed and altitude range of the supersonic aircraft.

Telephone and landlines will link the flight simulator with the NAFEC air traffic simulator. The telephone will serve as simulated radio contact between the simulator flight crew and the air traffic controllers in the NAFEC simulator. Landlines will be used for data transmission between the two facilities providing NAFEC controllers with aircraft position, altitude and radar beacon information.

NASA and FAA pilots will man the Langley simulator while FAA personnel will perform the traffic simulation at NAFEC. The Langley simulator will also be used to test other design problems such as cockpit displays, flight control systems and crew requirements and procedures.

In another development, FAA Administrator N. E. Halaby said last week that he hoped it would be possible for the Defense Dept. to assign a North American RS-70 Mach 3 reconnaissance strike bomber to FAA and NASA as a flying testbed for supersonic transport studies. He said the RS-70 could be used to study stability and control characteristics at Mach 3 speeds and the use of titanium in construction.

Halaby also said late last week that about $19 million in additional supersonic transport research contracts would be awarded soon.

FAA All-Weather Landing System Office Urged by Pilot's Report

Washington—Creation of a special Federal Aviation Agency office to develop and coordinate an all-weather landing program has been urged by a Trans World Airlines pilot after a 30-day study of the operational problem.

Capt. R. N. Buck, transatlantic turbojet pilot who made the study at the invitation of FAA called for more extensive interdepartment cooperation on the program, but warned against repeatedly adding new research ideas that could delay completion of the project.

While many possible techniques look attractive and promising, Buck said the submission of each idea to research and development could delay indefinitely, any solution of the problem.

To avoid the possibility of such delays, the all-weather program should be placed under a project manager aided by representatives of the airlines and pilots, he said.

Emphasizing the economic and safety requirements for an all-weather capability, Buck said that the most dangerous part of landings is when the aircraft is nearly in sight of the ground during a very low approach. At present visual flight must be used at these times and all-weather capability would close this gap, giving positive control of the aircraft all the way to the ground and during roll-out.

Internationally, the all-weather program is of great economic importance when compared to the programs of the British and French, who are particularly interested in all-weather capability because of the heavy fogs and low ceilings which characterize European winters. If the European carriers are able to land in poor weather and the U. S. flag airlines are not, it will put our overseas airlines in a bad competitive position, Buck said.

FAA Administrator N. E. Halaby said last week in Los Angeles that "it is time to design this type of system into the airplane from the very beginning." His remarks came just before he was scheduled to be briefed by Douglas Aircraft Co. officials on their proposed DC-9 short-haul jet transport (AW Feb. 25, p. 49). He said he presumed the DC-9 would have an all-weather capability.

To accelerate the all-weather landing program, FAA should establish a special airport survey team that would include representatives from Air Transport Assn., Air Line Pilots Assn. and general aviation. Buck said. The needs of all airports should be reviewed with particular emphasis on lighting, short runway conditions and the presence of obstructions.

Citing the need for improved approach and runway lighting, Buck noted that an FAA survey of landings showed that airline pilots tend to touch down about 1,800 ft. from the end of the runway rather than 1,000 ft., which is usually considered a safe distance. The measurements indicate that pilots are hesitant about their margin of landing safety during bad weather and demonstrate a need for visual approach slope indicator systems on all runways, along with cockpit instrumentation to show the aircraft's angle of attack, he said.

The report also dealt with the problem many pilots face in interpreting NOTAMS (notice to airmen) attached to the end of weather reports. In their present form, Buck said the NOTAMS expressed in coded abbreviations are of more help to the teletype system than they are to the pilot.

FAA's Flight Standards Service now has a project designed to simplify the minimum regulations for weather so that the pilot does not have to be as much a lawyer as he is now," the TWA pilot said. The project should be accelerated since any simplification of the NOTAMS will leave the pilot more time for such matters as considering instrument approaches.

EAL Plans Purchase Of DC-7F Freighters

New York—Eastern Air Lines plans to obtain DC-7F cargo aircraft to replace its four Lockheed Constellation freighters because of the DC-7F's higher cube density and compatibility with advanced loading mechanisms.

Plans are contingent on the outcome of Eastern's proposed merger with American Airlines, officials said. Rather than convert five or more of its own DC-7s for cargo use, Eastern could purchase DC-7Fs from carriers who have ordered jet freighters.

Carrier sees no immediate need for jet freighters—its longest cargo route segment being only 1,600 mi. Eastern may have an eventual need for a turboprop freighter of approximately 65,000-lb. payload if volumes continue to advance. But officials feel the Canadair CL-44 would not fill the need because of cube limitations.

Eastern's cargo volumes were up about 41% in January, and the field sales force has been expanded from eight to 17 men.

Pan Am, TWA Seek Early Merger Action

Washington—Pan American World Airways and Trans World Airlines made another bid last week to keep alive their proposed merger.

In a petition filed with the Civil Aeronautics Board last week, the two carriers requested reconsideration of a Board decision to defer the merger case until after the Transatlantic Route Renewal Case has been settled (AW Mar. 4, p. 33).

In addition to the CAB action, the proposed union has been buffeted by a new U. S. international air policy that is opposed to a single carrier operation on major routes (AW Feb. 11, p. 38), and White House merger guidelines that tend to discourage consolidations.

Another obstacle to the merger has been Howard Hughes, who, whether intentionally or unintentionally, has caused a one to two-year delay in the outcome of the case and has in effect forced a revision of the original merger agreement. Because Hughes defaulted on a suit brought against him by TWA (AW Feb. 18, p. 49), the airline stands to win a judgment from Hughes that could result in an increase of its net worth by $15 million or more.

The default by Hughes, whose 78% controlling stock is in the hands of a voting trusteeship, also has indirectly hindered a vote by TWA stockholders, which in turn caused the Board to defer proceedings in the merger case. In its deferral order, the Board expressed an opinion that a vote by TWA stockholders was impossible.

When TWA originally approached Pan American with a merger proposal, Pan American stated it would be interested only if the surviving company would not be controlled by Hughes. TWA agreed to this and the TWA voting trustees said they would vote at the regular stockholders meeting this spring.

They did indicate however, a preference to delay any public commitment to vote until the suit against Hughes reached court on Feb. 11 presumably to gain more leverage in working out a settlement with Hughes.

The default by Hughes changed the complexion of the merger agreement leaving the trustees in no position to evaluate the effects the merger would have on TWA stock interests. The default also could delay any action on the revised merger agreement for several years, since Hughes can appeal any default judgment rendered against him to the Court of Appeals and, finally, he could appeal the judgment to the Supreme Court.

In the joint petition for reconsideration of the Board's deferment of the merger proceedings, TWA indicated that the voting trustees will be ready soon to take a vote on the case. The petition said, "TWA is now prepared to submit the revised merger and sale agreement to stockholders for their vote as promptly as practicable after the matter of reopening the sale and merger agreement has been settled."

TWA also said it does not agree with the Board's statement that a definite vote on the merger proposals is impossible, nor with its implication that such a vote is required before Board action on the merger can be taken.

Many Pan American and TWA officials do not share the optimism of this official language and the feeling is strong that prospects for the merger are grim. In fact there is some conviction that Hughes may offer a far larger settlement on TWA's suit than the $15-20 million reportedly discussed as a settlement out of court last fall. In such an event, TWA could lose all interest in a merger at this time.

The first blow to the proposed merger was a declaration by the U. S. international air policy opposing the chosen instrument concept on major U. S. international routes.

The report of the Interagency Committee on Transport Mergers released by the White House earlier this month contains 10 criteria by which mergers should be evaluated by government agencies. Actually, the criteria represents a summary of existing laws and interpretations of those laws, compiled into capsule form for easy reference. As a result, the criteria statement is being viewed here as an Administration reminder of the many problems involved in the merger area.

It warns against mergers as a means of solving a short-term or transitory problem and asks "is the proposed merger in part because of the imminent failure of one or more of the merging carriers, and is it the most appropriate solution to this difficulty?"

Although the report is flexible in its advice on mergers, and stresses that all unions may not necessarily be required to meet all criteria in order to serve the public interest, the tone of the report suggests close and critical scrutiny of each merger proposal.

It will undoubtedly carry a lot of weight in the CAB's final decision in the American-Eastern merger and procedural steps in the Pan American-TWA merger. Meanwhile, growing concern in Congress over the merger issue in general was reflected in a report by a Senate anti-trust subcommittee calling for a moratorium on rail mergers.

In the CAB petition, TWA said that to move ahead with the route renewal case and defer the merger case would invert the normal and logical sequence of these two cases and will only result in a fruitless and meaningless inquiry into the North Atlantic route structure.

It noted that none of the interested parties has suggested the procedure adopted by the CAB, and added that a delay of three and one-half months in the route renewal case, within which time TWA expects to have a stockholders vote would not be detrimental to the public interest.

Local Service Group Study Backs Subsidy

Washington—Rapid expansion and improvement of local service airline operations should be considered adequate justification for the industry's annual subsidy payments, according to a recent study by the Assn. of Local Transport Airlines.

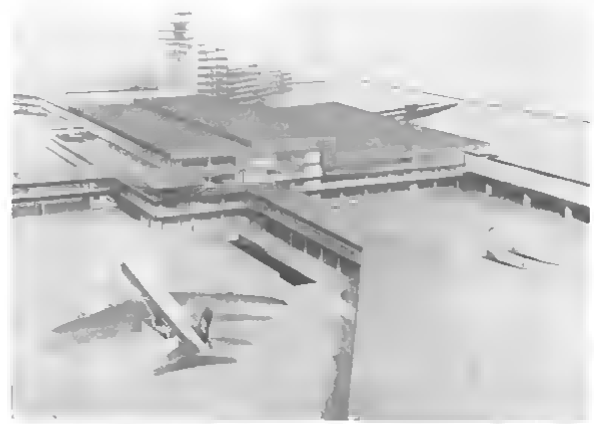
The group said the industry's 1962 subsidy bill of $66 million is "a small fraction of almost every one of the many other federal expenses for aid and special services." The volume of subsidy being paid is far outweighed by the increased service, ALTA said.

Local service traffic and commercial revenues have grown 4½ to 6½ times since 1957, while subsidy has expanded only 3½ times, ALTA said.

During the past 10 years local service route miles flown have increased 80% and the communities served have increased by 52%. Available seat miles flown and passengers carried both quadrupled in the decade, ALTA said. Flight frequencies have been increased to the point where local service aircraft now average one landing or takeoff every seven seconds during an average 16-hr. operational day.

ALTA cited payments to Ozark Airlines in 1961 as an example of benefits to smaller communities made possible by subsidy.

Ozark's nine largest cities accounted for 75% of the airline's total system population yet required only 26% of the total annual subsidy support. The remaining 36 smaller cities, comprising only 25% of the population, required 97.4% of the 1961 subsidy bill of 54,295,500. ALTA feels that this case exemplifies the nature of the local airline industry mission and demonstrates why continued federal subsidy support is necessary.



ARTIST'S IMPRESSION of Schiphol's future terminal area shows three-floor terminal with the administration building and control tower in the background. Project, scheduled for completion by 1967, will cost approximately $69,450,000. Airport will extend over 3,000 acres. Construction of underground railroad from airport to large cities is being considered.

Amsterdam Airport Modernization Scheduled for Completion in 1967

Amsterdam—Present modernization and expansion of Amsterdam's Schiphol Airport is designed to provide adequate facilities to accommodate anticipated passenger growth and aircraft movements during the next few years.

Estimated traffic by 1965 will total about 2 million passengers and 60,000 flights plus 75,000 tons of freight annually as compared with the 1961 totals of 1,505,000 passengers and 56,800 flights in addition to a freight turnover of 52,500 tons.

Corresponding estimates for 1970 are 3 million passengers, 75,000 flights and 140,000 tons of cargo. For 1975, they indicate 4 million passengers, 100,000 flights plus between 200,000 and 300,000 tons of freight.

Initial Redevelopment

Initial redevelopment was begun in 1960 and work is scheduled for completion by 1967 at a cost of $69,450,000.

This year the project will be pushed ahead at an accelerated rate in an effort to compensate for long intervals of adverse weather during the current winter.

Schiphol is the technical base of KLM Royal Dutch Airlines and seat of the Fokker Royal Dutch Aircraft Factories.

The airport authorities also would like to attract a number of other industrial enterprises to the area, particularly import and export companies interested in transporting their goods by air. But that is yet a long way off and nothing has been done thus far to promote the plan, a spokesman for the airport management told AVIATION WEEK & SPACE TECHNOLOGY.

When reconstruction is complete, Schiphol will extend over an area of 3,000 acres with provision for further expansion if desired. It now comprises 2,100 acres as compared with its original 190 acres of marshy pasture land in 1920 when it was established.

Modernization and extension program provides for a new administration building, a new control tower and terminal area with four 10,830-ft. long runways grouped tangentially around it. Two of the runways are now in operation and a third under construction is scheduled to be completed by 1965 to coincide with the inauguration of the new terminal area. Completion of the fourth runway is expected by 1967 after which the four runways will be used in pairs—two for takeoff and the other two for landing.

The third runway now being constructed in a northeasterly direction across one side of the terminal area will have connecting taxiways and holding positions at either end thereby reducing the distance to be covered by [illegible] aircraft to or from the center of the traffic area. Future location of the entire new runway and taxiway system will generally require the aircraft to taxi a relatively short distance to and from the terminal which will be connected by ramp structures at various points with the four runways encircling it.

The separate taxiways will include centerline lighting.

New main airport approach roads and additional ones, a car park for about 5,000 vehicles and a bus terminus located near the terminal building are included in the redevelopment program at Schiphol.

Underground Railroad

Possible construction of an underground railroad connecting the airport directly with a number of municipalities such as Amsterdam, The Hague and Rotterdam is being considered for a later date.

New terminal building will have three floors designed to enable customs and immigration officers to handle arriving, departing and transit passengers separately.

This plan, already in use at a number of other airports, is designed to eliminate unnecessary delays. Ground floor of the new terminal layout will handle arrivals; the first floor will take care of departures.

The latter arriving by bus or car on an elevated roadway leading to the entrance of the first floor will remain on this floor throughout the check-in procedure.

Upon leaving the aircraft arriving passengers will proceed through the piers to the first floor of the terminal building via covered mobile steel gangways leading to the ground floor for handling.

During the first stage of the development parking lots will be available alongside the piers for 25 aircraft. During the second stage the area will be extended to accommodate 30 and on completion of the project in 1967 parking lots will be able to handle a total of 45 aircraft.

Administration Building

Administration building will have 10 floors with an adjoining green center to be constructed near the terminal building.

The government aviation administrative services will be housed in a third structure while local air traffic will be controlled from the adjacent separate, 174-ft. high tower.

Ground traffic will be controlled by traffic controllers on the apron, rather than from the tower as at present. Airport surface movement radar will be available for minimum weather operation.

Turbine Aircraft

	OPERATIONS—ALL SERVICES								
	Revenue Miles (000)	Revenue Hours	Speed (mph)	No. of Aircraft	Daily Aircraft Hours	Daily Aircraft Util Miles	Non-Revenue Miles Number (000)	Non-Revenue Miles % of Revenue	Gals of Fuel Per Hour
BOEING 707									
Pan American	55,877.9	114,154	489	39	9.13	4,511	2,397.7	4.3	2,880
Trans World	54,813.9	114,754	478	46	8.56	4,266	1,887.9	3.4	2,317
American	33,944.2	68,728	492	23	8.15	4,060	771.3	2.3	2,073
Continental	8,636.8	18,057	478	4	11.16	5,391	93.2	1.1	2,375
Braniff	4,787.7	10,443	458	4	6.43	3,079	95.5	2.0	2,572
Western	2,144.3	4,822	445		9.09	4,069	31.1	1.5	2,247
EAL Interchange	256.9	548	469		2.44	1,284	2.2	0.9	
707 Total	160,361.7	331,586	484	115	8.51	4,281	5,268.9	3.3	2,319
DOUGLAS DC-8									
United	58,724.8	125,348	468	36	9.08	4,264	1,045.8	1.8	2,379
Pan American	30,175.7	62,660	482	19	8.50	4,258	1,124.2	3.7	2,624
Eastern	17,503.8	37,851	462	15	6.59	3,231	844.7	4.8	2,594
National	12,008.3	25,317	474	9	10.24	4,936	312.7	2.6	2,380
Delta	10,687.9	23,597	453	10	8.14	3,728	283.6	2.7	2,353
Northwest	7,929.7	16,476	481	5	9.29	4,565	115.9	1.5	2,399
Panagra	2,552.8	5,219	489	3	5.40	2,769	63.9	2.5	2,510
Trans-Caribbean	2,498.7	5,026	497	2	9.23	4,662	43.1	1.7	1,925
DC-8 Total	142,881.7	301,494	471	101	8.43	4,066	3,833.9	2.7	2,452
BOEING 720									
United	34,454.7	76,800	449	29	7.54	3,545	1,040.2	3.0	2,247
American	33,664.4	69,398	485	25	7.38	3,704	750.9	2.2	2,030
Eastern	15,131.1	34,936	433	15	6.33	2,839	1,205.6	8.0	2,321
Northwest	13,378.1	28,962	462	12	8.10	3,776	662.1	4.9	1,835
Western	6,919.3	14,927	464	7	7.55	3,667	180.9	2.6	2,162
Continental	4,032.5	8,347	483	4	10.11	4,918	89.7	2.2	1,885
Braniff	4,027.6	9,069	444	4	6.51	3,042	69.6	1.7	2,328
Trans World	4,026.2	8,375	481	1	7.22	3,538	38.6	1.0	2,057
Pacific Northern	1,725.2	3,618	477	2	7.16	3,464	23.3	1.4	1,963
720 Total	117,379.1	254,432	461	99	7.38	3,519	4,060.9	3.5	2,128
CONVAIR 990									
American	7,344.7	16,357	449	15	4.25	1,986	234.9	3.2	2,638
CONVAIR 880									
Trans World	23,155.9	49,725	466	20	6.31	3,169	897.2	3.9	2,183
Delta	17,852.9	37,694	474	16	7.27	3,531	643.7	3.6	2,164
Northeast	7,650.3	16,432	466	7	7.23	3,435	169.5	2.2	2,078
Alaska	1,260.0	2,637	478	1	7.13	3,452	87.5	6.9	1,936
880 Total	49,919.1	106,488	469	44	7.09	3,348	1,797.9	3.6	2,145
SUD CARAVELLE									
United	13,584.8	36,948	368	20	5.07	1,881	632.3	4.7	1,303
CANADAIR CL 44									
Flying Tiger	9,309.6	27,120	343	10	5.03	2,782	470.1	5.0	845
Seaboard	5,486.5	16,510	332	7	7.52	2,613	227.9	4.2	825
Slick	1,377.9	3,997	345	4	5.01	1,727	857.2	62.2	791
CL-44 Total	16,174.0	47,627	340	21	7.36	2,580	1,555.2	9.6	832
LOCKHEED ELECTRA									
American	19,237.3	64,275	299	26	6.10	1,848	587.0	3.1	804
Eastern	18,972.4	65,498	290	39	4.42	1,359	1,640.4	8.6	827
Northwest	12,084.6	39,073	309	16	6.41	2,069	253.4	2.1	764
National	10,172.4	33,518	303	15	6.28	1,960	97.0	1.0	776
Western	10,149.6	31,875	318	12	7.17	2,317	229.7	2.3	731
Braniff	6,618.9	21,162	313	9	6.45	2,109	121.2	1.8	766
Electra Total	77,235.2	255,401	302	117	5.57	1,888	2,928.7	3.8	788
VICKERS VISCOUNT									
United	23,698.5	103,176	230	47	6.02	1,385	426.2	1.8	475
Continental	9,189.6	35,087	262	12	7.49	2,049	92.9	1.0	514
Northeast	4,606.4	19,900	231	10	5.27	1,262	109.7	2.4	490
RNF Interchange	163.7	690	237		7.50	1,860	0.5	0.3	554
Viscount Total	37,658.2	158,853	237	69	6.18	1,486	629.3	1.7	488

1962 Operating and Traffic Statistics

	TRAFFIC IN SCHEDULED SERVICE								
	Revenue Miles (000)	Passenger Miles (000)	Passenger Load	Seat Miles (000)	Avail Seats	Passenger Load Factor (%)	Revenue Ton Miles (000)	Overall Load Factor (%)	Aircraft Capacity (Tons)
BOEING 707									
Pan American	49,625.5	3,856,769	77.7	6,735,501	135.7	57	529,662.9	56	19.09
Trans World	54,617.6	3,245,161	59.4	6,928,624	126.9	47	407,377.4	41	18.26
American	33,792.4	2,241,759	66.3	4,132,986	122.3	54	263,290.6	48	16.11
Continental	8,622.5	433,126	50.2	1,016,892	117.9	43	49,891.2	34	17.22
Braniff	4,718.6	265,261	56.2	526,867	111.7	50	30,999.4	39	16.87
Western	2,144.3	142,063	66.3	263,742	123.0	54	15,489.9	42	17.00
EAL Interchange	256.9	11,090	43.2	27,770	108.1	40	1,189.5	25	18.42
707 Total	153,777.8	10,195,229	66.3	19,632,382	127.7	52	1,297,900.9	47	17.94
DOUGLAS DC-8									
United	58,690.1	3,432,224	61.9	6,970,224	118.8	52	417,572.5	47	14.94
Pan American	30,144.8	1,836,017	60.9	3,690,427	122.4	50	250,582.5	50	16.53
Eastern	17,492.4	1,128,820	64.5	2,166,814	123.9	52	121,984.6	43	16.22
National	12,003.6	750,106	62.5	1,426,458	118.8	53	83,967.3	38	18.51
Delta	10,679.0	833,318	78.0	1,317,803	123.4	63	95,255.9	52	17.01
Northwest	7,912.3	424,268	53.6	846,434	107.0	50	72,852.7	53	17.49
Panagra	2,552.8	192,957	75.6	291,783	114.3	66	26,498.8	63	16.38
Trans-Caribbean	1,649.9	201,139	121.9	283,679	171.9	71	20,095.3	70	17.45
DC-8 Total	141,117.1	8,998,849	63.8	16,993,823	120.4	53	1,088,809.6	48	16.11
BOEING 720									
United	34,432.1	2,171,149	63.1	3,758,889	109.2	58	251,922.4	50	14.70
American	33,658.1	2,073,618	61.6	3,545,756	105.3	58	236,748.0	54	13.07
Eastern	15,131.1	839,138	55.5	1,832,073	121.1	46	90,681.4	42	14.32
Northwest	13,373.1	760,199	56.8	1,430,880	107.0	53	90,318.1	43	15.75
Western	6,916.2	496,276	71.8	832,171	120.3	60	53,412.4	48	16.09
Continental	4,017.5	193,374	48.1	427,338	106.6	45	22,644.0	37	15.42
Braniff	4,026.7	238,213	59.2	442,808	110.0	54	27,036.4	42	16.00
Trans World	4,020.6	222,314	55.3	446,271	110.0	50	24,709.9	45	13.65
Pacific Northern	1,725.2	71,540	41.5	206,936	119.9	35	12,165.9	51	13.90
720 Total	117,388.8	7,865,821	66.2	12,923,122	110.2	55	809,638.5	48	14.41
CONVAIR 990									
American	7,344.7	479,534	65.3	756,072	102.9	63	50,775.1	53	12.99
CONVAIR 880									
Trans World	23,138.4	1,196,061	51.7	2,128,226	92.0	56	128,620.3	48	11.54
Delta	17,840.1	969,217	54.3	1,558,546	87.4	62	106,652.0	54	11.07
Northeast	7,638.7	405,401	53.1	741,966	97.1	55	42,288.9	44	12.70
Alaska	1,227.2	51,698	42.1	125,179	102.0	41	7,030.4	53	10.80
880 Total	49,844.4	2,622,377	52.6	4,553,917	91.4	58	284,591.6	58	11.53
SUD CARAVELLE									
United	13,581.3	529,359	39.0	868,545	64.0	61	55,001.7	54	7.50
CANADAIR CL 44									
Flying Tiger	1,102.8						24,110.2	69	31.65
Seaboard	3,263.1						66,413.6	67	30.24
Slick									
CL-44 Total	4,365.9						90,523.8	88	30.59
LOCKHEED ELECTRA									
American	19,228.3	865,176	45.0	1,400,001	72.8	62	95,221.8	57	9.73
Eastern	18,965.4	608,967	32.1	1,254,804	66.2	49	67,431.4	34	10.34
Northwest	12,084.6	509,131	42.1	930,609	77.0	55	55,091.4	51	8.98
National	10,172.4	477,115	46.9	834,578	82.0	57	51,467.5	52	9.76
Western	10,145.8	473,252	46.6	886,568	87.4	53	48,623.6	45	10.65
Braniff	6,605.7	292,910	44.3	489,763	74.1	60	32,672.8	55	9.00
Electra Total	77,202.2	3,226,551	41.8	5,796,323	75.1	56	350,508.5	47	9.58
VICKERS VISCOUNT									
United	23,691.9	539,997	22.8	1,083,625	45.7	50	57,209.4	50	4.80
Continental	9,176.9	260,436	28.4	495,861	54.0	53	26,653.4	53	5.45
Northeast	4,603.9	124,483	27.0	202,571	44.0	61	12,491.8	57	4.80
RNF Interchange	163.7	5,465	33.4	9,072	55.4	60	543.6	62	5.37
Viscount Total	37,636.4	938,381	24.7	1,791,129	47.6	52	96,898.2	52	4.96

Prepared by Ray & Ray

AIRLINE OBSERVER

► New U.S. international air transportation policy (AW Feb. 11, p. 38) had an indirect influence on the Civil Aeronautics Board's decision to reject the round-trip fare increase proposed by the International Air Transport Assn. traffic conference (AW Oct. 22, p. 36). Government agencies involved in development of the policy felt that as long as the policy is firmly opposed to higher fares, the U.S. should not approve any rate increases. The Board decision was a reflection of this feeling.

► **U.S. scheduled airlines, both domestic and international, carried more than half the total number of passengers handled by the world's airlines during 1962. According to preliminary International Civil Aviation Organization figures, U.S. airlines carried 59 million passengers in 1963 compared with 110 million handled by the airlines of 90 nations. United Kingdom airlines were second with 7.8 million passengers. Canadian airlines carried 4.3 million, France 4.1 million and Brazil 3.6 million.**

► Bonanza Air Lines will petition the CAB for reconsideration of its opinion disapproving the carrier's purchase of three BAC 111 transports (AW Mar. 11, p. 302). Bonanza will provide further details of the BAC 111 performance in an effort to prove that the aircraft will reduce substantially the need for federal subsidy.

► Federal Aviation Agency has adopted a $3.8-million program to improve performance of instrument landing systems (ILS) and reduce ILS shutdowns through the installation of waveguide localizers, new type glide slope antennas and localizer and glide slope monitors.

► CAB staff group, headed by Irving Roth of the Bureau of Economic Regulation, has been talking with Military Air Transport Service officials on procedures for awarding contracts to airlines, regulations governing the Civil Reserve Air Fleet and MATS military operations during the Cuban crisis.

► American Society of Travel Agents has openly criticized International Air Transport Assn. for failure of member airlines to enforce regulations governing group travel discounts. ASTA charged that losses suffered by travel agents "as a result of customers turning to illegal groups continue to grow."

► Aeroflot is using An-12 turboprop transports—cargo and military versions of the An-10—to carry heavy equipment to the interior of the Chukotsk Peninsula, located just across the Bering Strait from Alaska. Loads are airlifted about 800 mi. from Magadan, on the Sea of Okhotsk, to the Bilibinski mining district. They include eight-ton trailer trucks, tractors, bulldozers and portable powerplants.

► President Kennedy, in a letter to Congress urging adoption of a U.S. transportation policy, recommended that legislation be enacted to make domestic trunk airlines ineligible for operative subsidies in the future.

► U.S. trunk and all-cargo carriers flew 6+9 million tons of air freight in domestic operations in January, a 12% increase over the 58 million carried in the same month of 1962.

► Russia has made another bid to Japan for the establishment of scheduled air service between the two countries. Five-man team from Japan Air Lines was to visit the Soviet Union late last week to make a technical survey of the possibilities of beginning such an operation. Previous talks have failed because of Russia's refusal to permit Japan Air Lines to fly into Moscow, and Japan has repeatedly rebuffed Soviet proposals that the air link between the two countries be established in eastern Siberia.

► U.S. trunkline revenue passenger miles increased 4.7% in February compared with the same month last year. Available seat miles rose 11.5% during the month to depress the industry average load factor to 49.5%, a 3.2% drop from the previous February. March traffic has been sharply reduced as a result of unfavorable weather throughout most of the nation.

SHORTLINES

► **Aeroflot** reports that Moscow originated 1.3 million passengers in 1961, compared with 520,000 in 1958. Leningrad originated 442,000 air passengers in 1961, against 92,000 in 1958.

► **Aerospace Industries Assn.** has formed a technical group to study the supersonic transport project and provide technical assistance to the government.

► **Air Transport Assn.** has received President Kennedy's "E" award for promoting exports of American products and developing increased tourist travel to the U.S.

► **Allegheny Airlines** will establish a charter aircraft division some time this year. Three aircraft, a 52-passenger Convair 340 and two 40-passenger Martin 404s, will be set aside for this service.

► **American Airlines** has filed with the Civil Aeronautics Board a proposal for a round-trip excursion fare on its transcontinental routes at 13.5% less than current coach rates. Under the proposal, the round trip must not be completed in less than 12 days or more than 30.

► **CAB** has denied petitions by TWA and Delta Air Lines requesting that American Airlines' new family fare plan be investigated and suspended until a decision is reached.

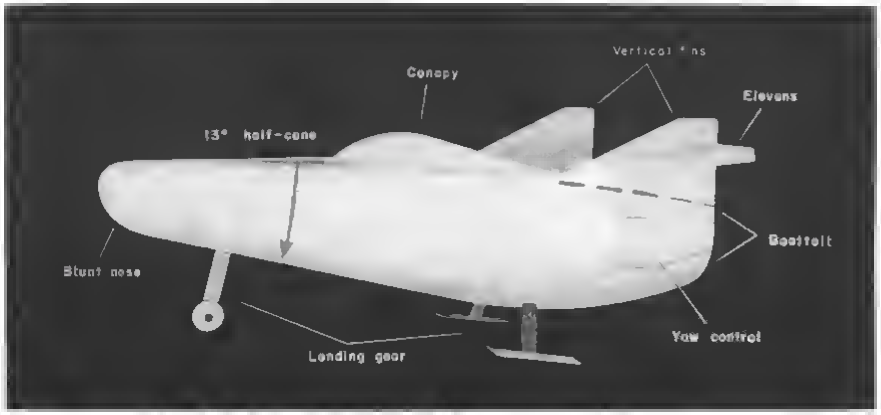
► **Handbook of Airline Statistics** compiled and published by the research and statistics division of the CAB's office of carrier accounts and statistics has drawn wide spread industry praise. The 559-page book is being adopted generally as a valuable reference work.

► **International Air Transport Assn.** has extended its reconfirmation rules to include parts of Africa, the Middle East and Turkey. Rule has been in effect in Europe, North America and the Far East for two years.

► **National Airlines** will inaugurate Douglas DC-8 jet service into Melbourne, Fla. on Apr. 28. It will be the first jet service into the Cape Canaveral area. Melbourne is 20 mi. south of the Cape.

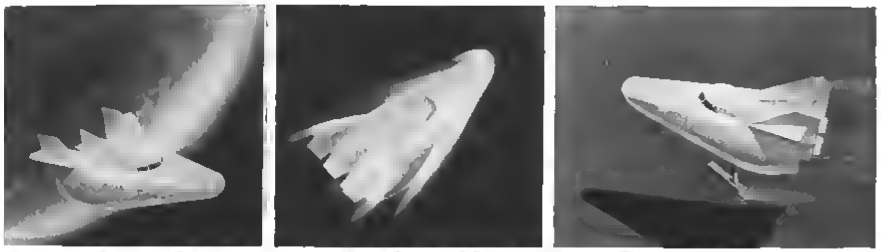
► **Sabena**, Belgian airline, has sold two of its Douglas DC-6B transports to the Swedish company Transair.

► **Western Air Lines** has asked the CAB for approval to adopt a group fare plan on its routes between Los Angeles and Portland and Seattle.

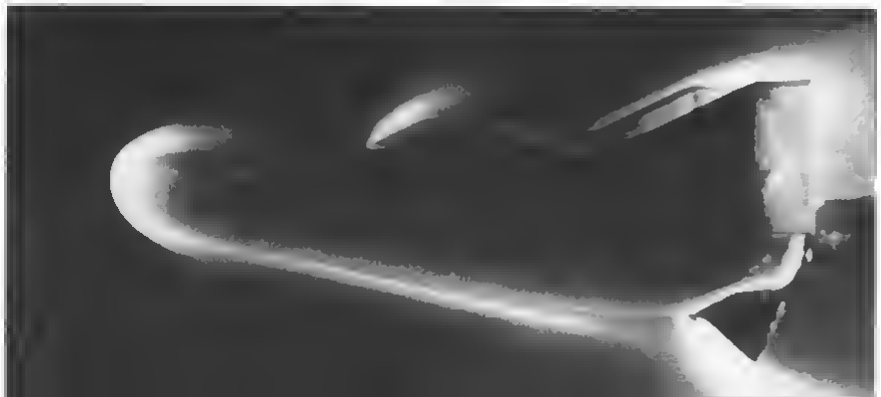


NASA Ames Research Center scientists have completed extensive wind-tunnel testing on a wingless, maneuverable spacecraft, designated M-2, and capable of orbiting the earth and landing like an aircraft. Basic features of the lifting body are depicted above. A wooden model will be test-flown in an unpowered flight within two months. NASA has no funds in the 1963-64 budget to develop the concept into a hardware program. Ames scientists say that the craft could give a returning astronaut over 1,000 mi. of lateral maneuverability.

NASA M-2 Lift Vehicle Prepared for Flight Tests



Sequence of artist's conceptions (above) show the vehicle leaving the vicinity of the earth (left), re-entering the earth's atmosphere (center), and landing after exercising its maneuvering capability. Below, model is shown during heating phase in a hypervelocity wind tunnel. Airflow was 14,000 fps., producing blunt nose temperature of 9,000F. Space vehicles would encounter heat in excess of this level.



NASA Plans Post-Nerva Follow-on Study

By Irving Stone

Los Angeles—Mission-oriented studies to define advanced design requirements for post-Nerva operational nuclear space propulsion systems for the 1970-80 period are planned by the National Aeronautics and Space Administration's Marshall Space Flight Center. Industry proposals for the task, projected to be a 12-month engineering effort involving 11,000 direct manhours, were submitted to MSFC early in March.

The studies are planned in anticipation of the long lead-time associated with propulsion system development. The current Nerva (nuclear engine for rocket vehicle applications) development project, representing the current state-of-the-art, is expected to be capable of some operational missions. However, its primary purpose is to prove the practicality of nuclear rocket systems in space-travel environment and develop experience in nuclear rocket technology.

The follow-on post-Nerva engine systems, to which the new studies are directed are expected to be designed from the outset for maximum operational use and flexibility in the national space program.

Two Engines

The study will include, but not necessarily be limited to, analysis of the following advanced nuclear propulsion categories:

• **Class 1 engine,** rated at 1,500 to 5,000 megawatts. Engine configuration and system parameters will be defined for delivery of passengers and/or cargo into lunar orbit, for unmanned planetary and solar probes, and for return stages of manned interplanetary vehicles. Heat generation of 1,000 Btu/sec would be required for a power output of 1 megawatt. A 5,000-megawatt engine would require generation of 5 million Btu/sec. The thrust equivalent of the 5,000 megawatt engine would be between 200,000 to 250,000 lb. By proportionate scale down, the 1,500-megawatt engine would deliver a thrust equivalent of 30% as much.

• **Class 2 engine,** rated at 5,000 to 15,000 megawatts. Configuration and system parameters will be the same as those for the class 1 engine, plus utilization for manned planetary missions.

Within the 1970-1980 period, it is expected that both the Saturn 5 and Nova class boost vehicles will be available with a capability for low earth orbital payloads ranging from 250,000 lb to 1 million lb., together with orbital rendezvous and mating techniques.

Analyses of configurations for the class 1 engine will include orbital-launched spacecraft with nuclear stage plus payload, varying from 500,000 to 1 million lb. for initial gross weight in orbit. The 500,000 lb. configuration would require more than one minimum capability Saturn 5 or Nova-class orbital booster plus rendezvous and mating operations in orbit to assemble the nuclear stage and its payload. The 1 million-lb. configuration would require a single Saturn 5 or Nova-class vehicle with maximum capability, or four minimum-capability (250,000-lb. payload) boosters.

System significant design variables which will be studied to determine the importance of each with relation to over-all mission performance, mode of operation, and transportation economics will include specific impulse, engine thrust power level (megawatt rating), power density (power generated per unit volume in reactor), system specific weight, burning time, chamber pressure and temperature, nozzle expansion ratio, stage structural mass fraction, staging arrangement, over-all engine and vehicle configuration, and shielding requirement.

Investigation of stage and propulsion parameters will include a range of 600 to 1,200 sec. for engine specific impulse, 0.1 to 30 for engine thrust-to-weight ratio, and 0.60 to 0.95 for stage mass fraction. Shielding requirement will be based on amount necessary to attenuate the total integrated energy deposition in the liquid hydrogen (working medium) to 10% of the unattenuated value.

Class 2 engine configurations to be investigated will include nuclear second and third stages, as well as nuclear spacecraft plus payload for orbital launch. Nuclear spacecraft plus payloads for orbital start will include those with weights of 500,000, 1 million, and 2 million lb. respectively. Saturn S-1C booster stage plus a nuclear second stage and Nova N-1 booster stage plus a nuclear third stage will be considered for sub-orbital start.

Systems parameters for the class 2 engine will be the same as those for class 1, plus consideration of clustering class 1 engines to achieve equivalent single-engine class 2 power levels. This will include preliminary layout and design studies of clustered engine concepts and problem areas.

The over-all study is planned to encompass four phases. Phases 3 and 4 will not be covered by the study but are outlined to indicate projected follow-on analysis. Details are:

• **Phase 1.** This portion of the study will require about three months and will outline the program, establish scope and magnitude of effort, and delineate detailed guidelines and assumptions for the study.

• **Phase 2.** This will require approximately nine months, will consist primarily of establishing mathematical parameters without particular regard whether certain parameters at the extreme ends can be achieved. Aim will be to determine relative importance of the parameters, for example, specific impulse relative to thrust or power density, or thrust-to-weight ratio relative to stage mass fraction, so that requirements for the engine and vehicle system can be established. This analysis also will indicate the sensitivity of parameters and the direction in which design improvements will yield the largest gain in over-all performance.

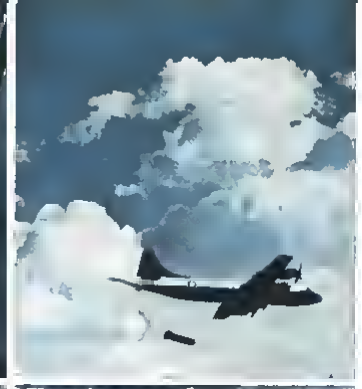
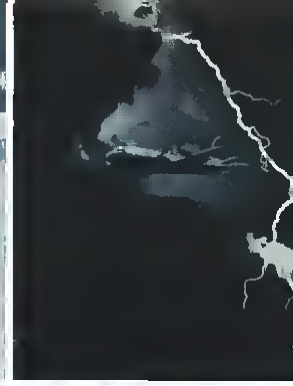
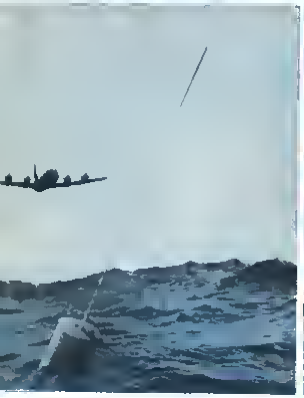
Related Studies

As a secondary effort during Phase 2, related technology studies will begin for application in Phases 3 and 4. This secondary effort will include, for example, investigation of engine clustering arrangements and practicality, staging concepts, maintenance problems, and tank weight and mass fraction as a function of liquid hydrogen capacity.

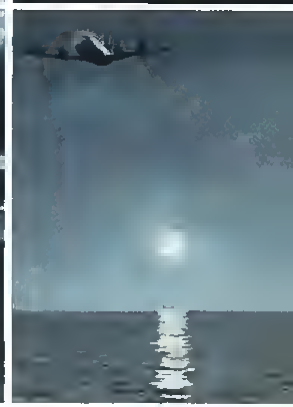
• **Phase 3.** This will be the system selection phase and will require six to nine months. The contractor for this phase will work in conjunction with NASA and concentrate on the requirements for the most realistic engine system expected to be attainable. The selection process will consider previous and concurrent advanced nuclear vehicle systems studies conducted by NASA. Results may indicate a requirement for more than one class of nuclear propulsion system to satisfy the projected requirement of the national space program.

During this study phase it is expected that conceptual and preliminary design study of the engine vehicle system will be initiated to support system selection process and to define the system further.

• **Phase 4.** This final effort will concentrate on detailed preliminary design, and will require three to six months.



HUNTER-KILLER:

The Navy's new P-3A Orions now patrol two oceans

Never has the need for surveillance of the seas around us been so pressing. For today the submarine is a growing threat to our cities as well as our ships.

One important aid in this task is the P-3A Orion. It can patrol and search far more ocean than any ASW airplane previously available. It is a land based airplane, which can be quickly deployed to any area in the world. With its combination of speed and endurance, the P-3A can carry out day-long missions covering thousands of miles of ocean. Two squadrons of these versatile hunter-killers are now operational.

To help the Navy improve its means of detection and tracking, Lockheed scientists are studying a broad spectrum of sea sciences...investigating underwater sound propagation, studying thermal effects, classifying noises, predicting sea states, developing tracking systems.

Lockheed-California's Anti-Submarine Warfare and Ocean Systems Organization coordinates a corporate-wide research effort that runs broad and deep—from the depths to the surface to the aerospace above.

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RECOVERABLE PASSENGER POD (left) is attached to an Atlas. Pod is heat-shielded to permit re-entry into the earth's atmosphere. Two open scientific passenger pods (right) show arrangement of experimental payloads.

Booster Orbital Piggyback Pod Studied

By C. M. Plattner

San Diego — Low-cost, sub-orbital space research technique of enclosing sensors in piggyback pods on Atlas boosters—developed here by General Dynamics/Astronautics for the Air Force—has led to design studies of an advanced pod capable of injecting a payload into orbit.

Contract for further development of the orbital pod, which has been financed so far by the company, is being negotiated with USAF Office of Aerospace Research (OAR). The pod probably will be flight tested in mid-1964.

Orbital pod will add greater versatility to the OAR-GD/A space research program, now built around two standard pods, recoverable and non-recoverable. Like the two standard pods, the orbital pod will be an integral unit, functioning independently of the booster.

Standard pods were developed by GD/A under an Air Force contract to take advantage of the full capabilities of Atlas R&D test vehicles, which are seldom launched with maximum payloads. Pods were designed so that two units could be attached to the boosters in tandem, providing two separate packages for experiments.

Piggyback pod experiments began in October, 1961, and have been carried out on a basis of non-interference with the primary mission of the launch vehicle. Although used only on the Atlas booster up to this time, the pods could be mounted on any booster capable of carrying extra payload weight, according to Astronautics.

Results of the piggyback experiments have been excellent with the 37 recoverable and non-recoverable pods launched from the Atlantic and Pacific Missile Ranges. Of the 15 pods containing unclassified experiments, only one failed to provide data and one provided partial data. The other 13 were successful.

Office of Aerospace Research directs the program and assigns experiments to the pods. Experiments have ranged from exhaust plume measurements to sensing cosmic ray neutron density. OAR requires all experiments to be sponsored by a government agency. However, industrial firms and educational institutions, working through such agencies, have conducted numerous experiments. USAF Ballistic Systems Div. monitors the contracts and acts as a clearing house for contractor payments.

Since no charge is levied for use of the booster, experimenters share expenses for only the pod, attendant equipment (batteries, ejection mechanism, etc.), launch services and data reduction. As project integrator, under contract to the Air Force, GD/A furnishes the pod and attendant equipment as well as engineering and technical services for launch and data reduction.

Total expenses shared by the experimenters for each pod launch average less than $100,000. This is roughly half the over-all average cost for individual rocket sounding shots, but it does not include sensors, which are furnished by the experimenter. Two or more sponsors' experiments are usually carried in each pod (maximum so far is nine) and expenses are pro-rated.

Wide diversity of environment is available for scientific experiments with the two pods now available, ranging from long-duration, zero-g conditions at high altitude to re-entry. On most flights, the pods reach an altitude of 600 mi., providing 25 to 30 min. of zero-g time. Special flights have reached an altitude of approximately 1,800 mi. with 45 min. zero-g time.

Standard non-recoverable pod con-

sists of payload and telemetry sections and a low drag bullet-shaped nose. Outer construction is aluminum alloy except for glass-fiber nose fairings. Pods are secured to the vehicle between the booster engine section and the fuel tank. This area minimizes center of gravity shift, and no changes in Atlas autopilot settings are required.

Double-cradle system is employed to attach the pod to the launch vehicle. One cradle is bolted directly to brackets welded to the Atlas booster, and the other is affixed to the pod. Cables secure the two cradles together. Prior to ejection these are severed by a cutter which is actuated by an explosive charge.

Fairing streamlines the space between the pod and carrier vehicle, and umbilical fittings and ground-cooling inlets are provided. The 30-in.-dia. non-recoverable pod is 8.5 ft long and has a payload capability of 339 lb. Weight of the basic pod structure, ejection mechanism and integral systems is 261 lb.

Pod functions as follows:

• **Ejection system** jettisons the pod at proper launch vehicle attitude and altitude, upon command from the programmer. The mechanism can either be pneumatic or spring-actuated. The spring system, employing scissors-type springs, can eject a pod laterally from the vehicle at 1 fps. up to 0.25g longitudinal acceleration. The pneumatic cylinder device can eject a pod laterally at 5.5 fps. during booster accelerations up to 2.0g.

• **Electrical system,** a 28-v.d.c., 15-amp silver-zinc battery with a 60-min. life under load, provides up to 250 w. of power for experiments. Battery supplies power to instrumentation at launch and during flight. External power is supplied to the unit on the ground through an umbilical cord.

• **Programmer supplies** step or pulse outputs to operate the payload sensors during flight. The solid state device has a tuning fork time standard with a maximum tuning error of 0.1% or ±3 millisec. The programmer provides timing for five events and operates up to 2,048 sec after liftoff.

• **PAM/FM/FM** telemetry system operating in the 215 to 260 mc. band transmits experimental data and programmer functions to ground receiving stations up to the time of re-entry. Signals can be transmitted on six channels, three of which may be commutated to handle 25 measurements each. Capability can be expanded by additional channel use and commutations to transmit up to 150 measurements. Two cavity-type antennas are flush-mounted on opposite sides of the pod providing essentially 360 deg. coverage.

Recoverable pod, which is reusable, incorporates the same telemetry, electrical, programmer, and ejection systems as the non-recoverable version. Difference between the two is in the outer pod structure, which allows the recoverable pod to survive re-entry heating. The shell is made of phenolic glass fiber with phenolic refrasil (an ablative substance of layered glass fiber) wrapping. Nose is hemispherical in shape, and over-all length is 6½ ft. A flared aft end encloses the recovery system.

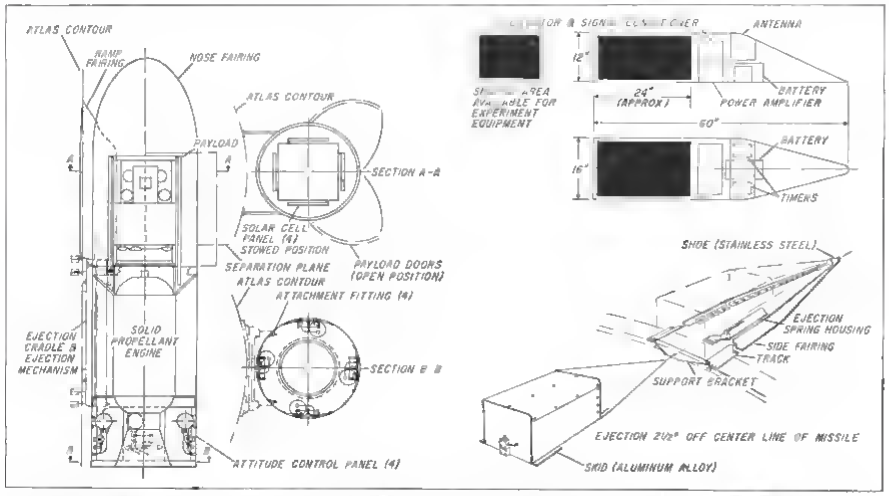
During re-entry, a drogue chute deploys at 28,000 ft., slowing the pod's descent to acceptable main chute deployment speed. The main chute opens at about 11,000 ft. Recovery of the pod, which is buoyant, is facilitated by a radio beacon, flashing light and dye marker.

Configuration of the orbital pod resembles the non-recoverable unit but will be longer—a total of 12 ft.—to accommodate the booster rocket and attitude control unit. The 30-in.-dia. pod will be attached to the launch vehicle by the same weldments used to secure the standard pods.

Orbital pod is designed to place a payload of approximately 450 lb. into an eccentric or circular orbit. Only the payload, the power unit and associated control system are ejected, leaving the outer shell of the pod attached to the vehicle.

After ejection, a nitrogen jet attitude control system stabilizes and orients the payload and booster so that the unit is pointed in proper direction. A solid-propellant hot gas attitude control system, commanded by the autopilot, is actuated prior to booster ignition, providing attitude control during the flight into orbit. Booster and attitude control unit are jettisoned after the payload has attained the orbit.

Propulsion system for the orbital pod



DETAILS OF ORBITAL PDD are shown in drawings at left. Layout and ejection system of small pod is shown at right. Orbital pod will add greater versatility to the Air Force's space research program. Pod will be an integral unit, functioning independently of the booster vehicle, and is designed to place a 450 lb. payload into an eccentric or circular orbit.

MICROMODULES—Microminiature electronic circuitry in modules. (GAC is one of only four companies designated by the U S Army as qualified to solicit such systems.) For satellites, missiles, other aerospace vehicles. Use of modules permits six-fold reduction in weight over conventional miniature circuits—packing densities of 90,000 to 300,000 parts per cubic foot

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HIGH RESOLUTION RADAR via doppler beam sharpening technique. Originated by GAC. Used on the McDonnell Aircraft U S Air Force F-4C for surveillance of terrain *in almost photographic detail*, at previously out-of-range distances.

GAC has proved experience in aerospace electronics!

Aerospace is our business at GAC—Goodyear Aircraft Corporation. And electronics is a big part of it.

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GOODYEAR

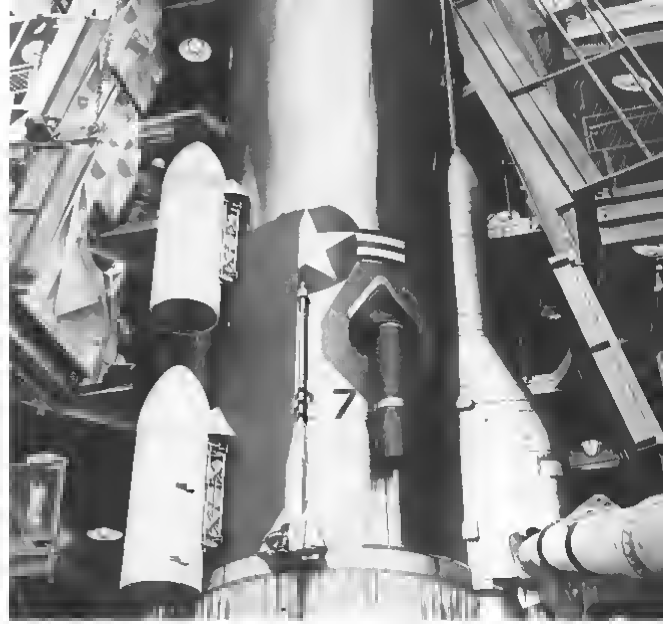
GOODYEAR AIRCRAFT CORPORATION

is still not decided, but the leading contender is the solid-propellant Allegheny Ballistics Laboratory X-258. The X-258 has a maximum thrust of 5,080 lb., a specific impulse of 278 sec. and a firing time of 28 sec. Usable propellant weight is 512 lb.

Electrical Power

Electrical power for the orbiting payload could be provided by a solar cell array and nickel-cadmium battery. During sunlight portions of the orbit, solar cells, which might be either deployed paddles or fixed panels, would provide power to the satellite's systems and charge the battery. During dark portions of the orbit, the battery would be the power source. Depending on the experiments carried, the power supply, telemetry, antennas and attitude stabilization systems can be varied to meet requirements.

In orbit the satellite payload will traverse light and dark periods at a sufficient rate to permit passive temperature control with surface coatings. Temperature will be controlled on the ground through an air-circulation system. During ascent, the low drag nose fairing and thermal shroud will minimize heating.



TWO STANDARD scientific passenger pods are mounted in tandem on an Atlas missile. The pods and Atlas are produced by General Dynamics/Astronautics.

Expandable Nozzle Skirts Are Tested

Tullahoma, Tenn.—Six experimental expandable rocket engine nozzle skirts—three fabricated of very thin stainless steel and three of rubber—have been tested here in the Air Force Arnold Engineering Development Center's high-altitude cell by Aerojet-General Corp.

Both Air Force and National Aeronautics and Space Administration have been interested in the development of expandable nozzles for greater efficiency of rocket engines operating at the very low pressures of extremely high altitudes. Diameter of nozzle exit cones of any current upper-stage engines is effectively limited by the diameter of its launch vehicle's airframe.

Expandable nozzle if successfully developed could allow an upper-stage engine to use a nozzle with a much larger diameter than that which could be carried normally on the booster. Nozzle would be collapsed during the boost phase of flight but would be expanded after staging and after ignition of the upper stage engine.

Stainless steel skirts built by Aerojet are cylindrical prior to firing and convoluted longitudinally. Convolutions of the less-than-0.01-in.-thin skin vary axially from about 1 in. deep at the bottom of the cone—where the most expansion occurs—to about 0.5 in. deep at the top of the skirt where it attaches to a fixed and regeneratively cooled upper segment.

Diameter of the approximately 4-ft.-long skirt is about 20 in. prior to expansion and about 56 in. after expansion. Area expansion ratio of the skirt is about 40 to 1. The regeneratively-cooled segment has an area expansion ratio of about 8 to 1.

Skirt has a slight conical contour after expansion.

Rubber skirts used so far in tests are about 0.5 in. thick and are fabricated fully expanded. Rubber, said to be of an ablating butyl type with a cord body, can be folded up and around or up and inside the upper segment of the engine nozzle.

Tests, using a 10,000-lb. thrust Aerojet engine burning nitrogen tetroxide and aerozene, have been successful. Most recent test here, on Feb. 25, was terminated prematurely after 5 sec. of a scheduled 30-sec. run when the test cell suddenly lost water cooling. Engine then shut down and the consequent back pressure collapsed and wrinkled the steel skirt. Skirt had expanded normally in milliseconds after engine ignition. Altitude simulated in the cell was 100,000 ft.

Program is being sponsored by USAF's Rocket Development Laboratory at Edwards AFB, Calif.

MA-9 Rewiring

Houston — General Dynamics/Astronautics rewiring of the MA-9 booster, which caused rescheduling of the launch to mid-May (AW Feb. 11, p. 35), has been pinpointed.

Suspect area is wire connector points on circuit trays in four canisters for autopilot, programmer, gyro package and servo amplifier. Two 10-strand wires are soldered to each connector point. However, wire diameter was too large to permit direct insertion and soldering of both wire ends in connector sockets, so an adapter was employed having a socket sufficiently large so wires could be inserted and soldered in the adapter. Pin end of the adapter was then inserted into the connector circuit and soldered. General Dynamics analysis indicated the possibility of the connection being degraded because of a cold solder joint occurring during the second soldering operation.

There is now some speculation by Mercury program technicians that connector failures in one of the canisters may have been the cause of the hitherto unexplained control failure in the MA-3 launch vehicle, designed to orbit a mechanical astronaut, which was destroyed by the range safety officer 40 sec. after liftoff on Apr. 25, 1961.

NASA Considers Use of Aircraft For Remote Apollo Crew Retrieval

Houston—Technicians at Manned Spacecraft Center here are considering use of high speed, long range aircraft carrying special equipment to locate Apollo manned space vehicles which might land at locations remote from normal recovery forces.

Envisioned technique also includes air-snatch capability to retrieve the Apollo crew according to officials of the National Aeronautics and Space Administration center.

Because of possible malfunctions which might require a mission abort after translunar injection, including primary re-entry guidance and control system failures, the Apollo vehicle might touch down at any point over a large part of the earth's surface. In such cases, radar tracking during re-entry as an aid to landing point determination might be prohibitively expensive.

One plan calls for equipping high speed, long-range aircraft with high frequency direction finding systems, according to Sigurd Sjoberg technical assistant to the center's Flight Operations Div chief.

Approximately 20 such airplanes, including backup aircraft would be sufficient for the search operation under consideration. Furthermore, development of a reliable technique for air pickup of the downed crew would be highly advantageous, Sjoberg said since it could also eliminate the need for some planned lower-probability landing areas.

Recovery of the spacecraft could be accomplished by surface vessels at a more leisurely pace after the flight crew had been retrieved.

Some of the changes that are being considered in flight control and monitoring of the Mercury MA 9, Gemini, and Apollo programs, noted by Sjoberg, include:

- **Only** significant change for the one-day MA 9 mission is that two shifts of personnel will be required in the Mission Control Center and a few of the remote stations. These crews would operate on a 10 hr basis, with an overlap of about one orbit between shifts. Shifts will not be required at most of the remote stations because these will not be in contact with the spacecraft for a considerable number of orbits.
- **Substantial changes** are planned for the Gemini flight control and monitoring program according to Sjoberg. The new Integrated Mission Control Center (IMCC) at Houston will be utilized beginning with the rendezvous flights. The ground computer complex and communications center will be part of IMCC operations. For longer duration Gemini missions, three shifts will be required at the control center and two at the remote sites. It is anticipated that there will be a decrease in the number of personnel in the operations room. However, there will be a large increase in the number of systems and mission specialist support for operations room personnel because of the greater complexities of the flights, including rendezvous, docking and longer-duration missions.

In Mercury missions the computing complex is used only for developing trajectory data. With Gemini, the computers will also be used to assist in performing system analysis, such as determining the best way of using the on-board propulsion system for rendezvous. Sjoberg also pointed out that there will be fewer remote stations in the Gemini program. It is expected that two additional flight control and monitoring personnel will be required for each of the two shifts at the remote stations.

- **Project Apollo** flight control and monitoring will require additional system and mission specialists beyond those used for the Gemini program. It is highly desirable to reduce remote site personnel requirements, Sjoberg stated. The main problem, he said, is to provide adequate data and information to the control center via data links which are not adequate for the information flow requirements. One solution to this problem would be to provide data processors at the remote sites so that only processed data is transmitted to the control center. This system would greatly reduce total data flow and allow flight monitoring personnel to be decreased. This idea is now under study by the space agency for possible application to the Apollo lunar landing program.

Nuclear Powerplant

Mobile nuclear powerplant, the ML-1, under development for the Army has completed a 100-hr run. Unit was designed by Aerojet-General Nucleonics Div and produced more than 250 kw. In field service it is expected to produce from 300 to 500 kw.

Powerplant will provide a transportable source of electrical power, independent of conventional fuel needs, for field hospitals, command and communications posts, Red Cross emergency stations, remote radar stations, or for other outposts.

Two outboard pylons on the YB-26K would be used to carry rocket-launching pods since two inboard pylons are restricted to droppable stores because of propeller arc. All-weather capability for the aircraft has been provided by adding anti-icing and de-icing equipment. The YB-26K is shown at San Fernando Valley Airport prior to its delivery to USAF's Special Air Weapons Center.

YB-26K Interim Counter-Insurgency Plane Shown

YB-26K interim counter-insurgency aircraft was recently delivered to the Special Air Weapons Center, Eglin AFB, for testing (AW Mar. 4, p. 32). Aircraft, basically a Douglas B-26B, was modified by On Mark Engineering, Van Nuys, Calif. Modifications include addition of 165-gal. tip tanks and wing pylons. Outboard inboard stores are 100-lb. general purpose bomb, 500-lb. GP, 750-lb. fire bomb or napalm, and 230-gal. droppable fuel tank. Eight guns in nose and six in wings are M3 .50 cal. Fin vortex generators (right of hinge between vertical fin and rudder surface), increased rudder area, and anti-servo tabs have reduced V_{mc} (minimum single engine control speed) from 122 kt. in the B-26B to 100 kt. for the YB-26K despite larger P&W R-2800-103W engines used. Propeller is Hamilton Standard 43E60-6895A-20, 12½ ft. reversible with auto-feathering.

PHOTO'S show XB-70 brake tests under conditions simulating rejected takeoff. Photos show gear before, during and after contact.

USAF Performs Tests on XB-70 Brakes

Dayton, Ohio—Test of XB-70 brakes under conditions simulating rejected takeoff with full braking at maximum gross weight was carried out recently by Aeronautical Systems Div. at Wright-Patterson AFB.

Single brake stack with two tires impacted with a force of 60 tons when Wright Field's 16-ft. dynamometer reached programed speed of 200 mph. Pressure, representing the test gear's portion of the XB-70's gross weight of 530,000 lb., was maintained until the stop was achieved.

Program called for zero deceleration within 34 sec., which represented 5,000 ft. of runway from the refusal point. Time required in the test was 45 sec., or 6,500 ft. Ralph M. Reinhardt, chief of airframe division, B-70 engineering office, said "some torque fade during the low speed of the test" caused the lengthier run.

Total Distance

Officials of both ASD and B. F. Goodrich Co., brake, wheel and tire contractor, were satisfied, however, because the brakes showed they could absorb nearly 200 million ft./lb. of kinetic energy in coming to a stop. Total distance from start of takeoff to stop would have required a minimum runway of 13,500 ft. since distance from start to refusal point was estimated at 7,000 ft.

During deceleration, which simulated conditions of brake stress 20% over design requirements, considerable smoke, sparks and flashes were noted. The smoke and flashes continued 10 min. after stop. Sparks and flashes were diagnosed as metal particles coming from the brake while some of the smoke emanated from the tires.

Temperatures of components during the test were within expected limits. Brakes exceeded 2,000F. Tire temperatures, at 250F were normal. Thermal pressure relief valves were set to deflate tires if temperature exceeded 460F.

Problem Encountered

Only one problem was encountered during the flywheel's 15-min. acceleration to the 200 mph. speed—the test apparatus hydraulic ram was unable to hold the gear on the flywheel with the proper pressure. Second try was successful. Wheels were not brought up to speed with the flywheel since the 15-min. time period would have resulted in unrealistically high tire temperatures.

Design of the gear involves engineering breakthroughs—use of electronic computers with brakes and use of tires qualified through a heat spectrum of 360 deg. in flight.

Each main gear is composed of a beam, called a bogey, with two brake stacks and four wheels, two per stack. The stacks are made up of 21 stationary and 20 revolving discs. The stationary discs are splined to a stator ring cage and the rotating ones to the torque tube. The torque tube is splined to the wheels.

There is no axle as such, the bogey beam performs that function with the wheels fitted over bearings mounted on it. The bogey beam weighs about 1,000 lb. and is an 11-11 steel forging.

Brakes are separated from the wheels because of the energy involved and thus there is no need to jack up the aircraft to remove the brakes. Engineers said that if a conventional type wheel and brake arrangement had been attempted a test of this type would have blown the tires long before a stop was achieved.

Brakes are actuated as follows: Conventional brake pedals are depressed and this actuates a sensor which determines amount of pressure to be applied. This input is then transmitted to a valve which controls the hydraulic pressure to the brake. Pistons apply pressure on the stationary discs, forcing them against the rotating discs. Upon release of pressure, discs tend to separate without any actuator since they are not perfectly mated and are not intended to be.

Another innovation in the design is the sealing of the hydraulic actuators with metallic seals.

Brake Linings

The brake linings are constructed of sintered iron, selected from several materials, including a copper-bronze base. Even within the area of sintered iron materials there were some problems initially. In some instances the wear rate was too high even when the braking coefficient was within specifications.

Mounted on each of the two bogey's is a fifth wheel called the sensor wheel,

housing an electronic speed sensor. This small diameter wheel measures the true ground speed of the aircraft on the runway, allowing for no slip and is coupled with an electronic speed sensor on the wheel being braked. This sensor wheel feeds an input to the slip computer and from the difference in rpm between the sensor wheel and the braked wheel the degree of slippage of the braked wheel is determined.

Another input from the braked wheel speed sensor is fed into the ground coefficient computer. This information, together with a brake torque sensor input, determines the ground coefficient or the traction coefficient available between the tire and the runway surface. To determine optimum braking, the maximum ground coefficient must be utilized. Computers are manufactured by Pneumo Dynamics Co. of Grand Rapids, Mich.

Optimum Braking

Optimum braking, according to Dale Creech, ASD senior project engineer on the landing gear system, on the ground is with about 12% slip which gives the best torque. When the slip is above 15% the propensity to skid begins to develop.

The slip computer is employed here being set at 15% slip, the limit for the system.

Brakes are automatically released when this point is passed. The slip computer and the ground coefficient computer feed inputs into a slope computer which maintains optimum braking of 12% regardless of the runway conditions.

Tires selected are 40x17.50-18, type 8 wide profile types. For the test they were inflated to approximately 350 psi to obtain proper deflection of the tire. The tires are rated at 320 psi and are silver in color in order to reduce heat absorption.

Comments on Gear

Comments from officials witnessing the test varied but most seemed surprised that the gear withstood the trial as well as it did. Brig. Gen. Fred J. Ascani, ASD deputy commander for B-70, reacted representatively when he said "We had a brake all along. I know that, but frankly I didn't think it would go through all that. I'm always tickled when we make it through what is really a test to destruction."

Testing chronology at ASD for the landing gear is as follows: Tire qualification, June, 1961, completed wheel testing, August, 1962; brake control system, December, 1962, completed brake braking qualification tests, January, 1963. Drop testing is scheduled for completion this month.

Tire quality development has completed last month.

PRODUCTION BRIEFING

Hamilton Standard Div. of United Aircraft Corp. is studying the feasibility of using electron beam welding for fabricating or repairing spacecraft in outer space. Study, which is financed by a $340,000 Air Force contract, will include the building of experimental welding equipment which will be tested in a vacuum chamber and the development of power sources which use solar generators, fuel cells or nuclear reactors.

Chaney and James Construction Co., Dallas, Tex., has been awarded a $3,752,791 contract for construction of the F-1 rocket engine static test stand at National Aeronautics and Space Administration's Marshall Space Flight Center.

Martin Co.'s Denver Div. will design, fabricate and test an expandable earthbound model of a space structure, which will be capable of increasing its length like a telescope, under a $483,000 contract from Air Force Systems Command's Aeronautical Systems Div.

Meg Products Div. of Mandrel Industries, Inc., Seattle, will fabricate cable assemblies for Air Force's Minuteman program under a $2 million contract from Boeing Co. Space Corp., of Garland, Tex., will build mobile maintenance and support equipment for the Minuteman under a $500,000 Boeing contract.

Weber Aircraft Corp. will design, develop and test an ejection seat escape system for Canadian Air Force's CL-41A jet trainer, under a contract from Canadair, Ltd.

Lear Siegler's Instrument Div. and North American's Rocketdyne Div., prime and subcontractors respectively, will conduct a joint program to determine what engine operation information must be visually presented to pilots of rocket powered vehicles and what the best method of display will be for cockpit panels. Joint study is financed by a contract from Air Force's Aeronautical Systems Div.

Telecomputing Corp.'s Whittaker Controls and Guidance Div. will build miniature attitude reference systems (MARS) designed to obtain roll, pitch, and yaw information from spinning rocket vehicles, under a $600,000 contract from Sandia Corp.

Boeing Co. has awarded two subcontracts for development of components for the X-20 Dyna Soar space vehicle. Cosmodyne Corp., Hawthorne, Calif., will build hydrogen pumping units under a $162,000 contract and Sun Electric Corp., Chicago, Ill., will build hydraulic power supply equipment under a $96,000 contract.

Minneapolis-Honeywell Regulator Co.'s Aeronautical Div. has been awarded a $3-million Navy contract for production of inertial guidance platforms for the Polaris missile. Mk. 2 guidance system. Mk. 2 system was developed by MIT for the advanced Polaris A3.

Ryan Aeronautical Co. has received a $6-million follow-on contract for continued production of the Q-2C Firebee jet target missile. Contract covers production of 150 units for use by Navy and Air Force, with deliveries extending through 1964.

Helodyne Corp., Los Angeles, Calif., has been awarded a $102,849 Army contract for research in hypervelocity base flow and wake studies, which will contribute to the description and specification of targets that radars and other instrumentation will have to deal with in ballistic missile defense systems. Studies are part of Army's Project Defender and are sponsored by DOD's Advanced Research Projects Agency.

Chance Vought Astronautics, a division of Ling-Temco-Vought, has been awarded an $86,966 National Aeronautics and Space Administration contract for an exploratory study of guidance system techniques in emergency abort operations of the Apollo Lunar Excursion Module (LEM). NASA also has awarded a $165,000 fixed-price contract to the USAF Aeronautical Chart and Information Center, St. Louis for lunar charting service.

Goodyear Aircraft Corp. will design and construct an expandable antenna for use on planetary spacecraft such as the Mariner, under a contract from the Jet Propulsion Laboratory (JPL) of the California Institute of Technology. The 12 ft.-dia. antenna will consist of curved radial ribs folded around a circular hub. It will be packed in a 4-ft.-dia. package for launching and will be used in space to relay communications back to earth.

Catalytic Construction Co. has won a $5.5 million NASA contract to build a synchrocyclotron designed to accelerate protons up to 600 million electron volts. The accelerator will be operated by several Virginia universities and will be located near Langley Research Center, which will have management responsibility.

PROBLEMATICAL RECREATIONS 162

A railroad buys ties for $1 t apiece. They last for ten years and then have a scrap value of $1 apiece. If preservative treatment costing $3 a tie is applied, each tie will last 15 years but will have no scrap value. If the railroad makes 5% on its capital, should it treat the ties?

—Contributed

Going to New York next week for the I-triple-E? Pack your résumé and plan to drop by the Career Center at the Summit Hotel. Gentlemen from our Guidance and Control Systems Division will be on hand to discuss interesting positions in navigation and digital computer components and systems. We hope to see you at the Summit.

ANSWER TO LAST WEEK'S PROBLEM: Use of log table or slide rule involves unnecessary inaccuracy and time consumption. Simply raise both numbers to the 30th power, giving 1000 and 1024 respectively. Hence the cube root of two is larger.

Northrop will start production of F-5 fighter in Hawthorne, Calif., in next few months in assembly system parallel to that of the T-38. Northrop's assembly area is shown at left. Adjacent to the forward fuselages, the center fuselages of both planes will move along a rail system attached underneath a seven-foot high platform. The twin rail-suspended lines will have a total length of more than a quarter mile. Suspended assembly lines begin at center platform in photo at right.

Northrop to Use T-38 Assembly Techniques for F-5

Completed forward fuselages will join the center fuselages and the sections are mated during passage along the system. The twin mating lines have eight stations each, the last of which is a shipping position. Completed fuselages are loaded directly from the lines onto trucks. Final assembly—installation of engines, armaments for F-5s, flight and navigation aids—takes place at Palmdale, Calif. Both assembly lines can be supplemented with a third, using the present system as a base. Photo shows an advanced stage of the assembly of the T-38. The F-5 fighters will be assembled in the area at right.

Suction Cups Tested In Helicopter Landings

Bedford, England—Royal Navy has experimented with suction cups on helicopter landing gear to secure them to frigate decks during landings in rough seas.

Experiment has been run in conjunction with Royal Aircraft Establishment Naval Section using a Westland Wasp powered by a 1,050-shp Bristol Siddeley Nimbus free turbine engine. Engine has been torque limited to 685 shp. to enable maintenance of sea level performance under all operating conditions.

RAE has developed a platform which simulates ship motion in order to test helicopter landing characteristics on rolling decks. Platform is 24-ft.-square and is covered with anti-skid paint, impregnated with carborundum particles. Platform is rocked by an electric motor. Roll angles of up to ±15 deg. are available, simulating the roll rate of a 2,700 ton frigate.

R. R. Duddy, head of the RAE Naval Air Dept., said the platform can be moved into an adjacent hangar so that tests of dummy helicopters may be carried out under laboratory conditions.

In a demonstration at Bedford, Westland Test Pilot John Morton successfully landed a Wasp eight times on the platform, which was set for a 4-deg. roll ratio. Figure was selected because of adverse wind and weather conditions; wind was gusting to 30 kt. from east-southeast and the platform could not be positioned to take full advantage of this, as could a ship.

Cdr. A. J. R. Pegler of the Royal Navy said the suction system was developed after considerable testing of a winch-down system now being studied in the U.S. and Canada. Difficulty in the latter system, as far as the Royal Navy is concerned, is extensive modification to helicopters and ships to carry the additional equipment.

In the suction cup system, Cdr. Pegler said, pads replace the wheels, each consists of a flat metal plate with a rubber seal bonded to the periphery. Air is bled from the main powerplant to create a partial vacuum when the pads are in contact with the deck. Deck handling can be facilitated by reversing suction flow for lifting ground effect.

Another system under study by Royal Navy, but with less emphasis is the use of a harpoon and grid. Grid of steel bars is mounted at deck level, and this is engaged by a barbed harpoon attached to the belly of the helicopter. On landing, the harpoon is forced into the grid and the barbs engage the bars. Barbs can be designed to retract hydraulically or pneumatically.

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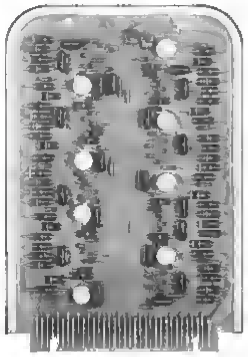

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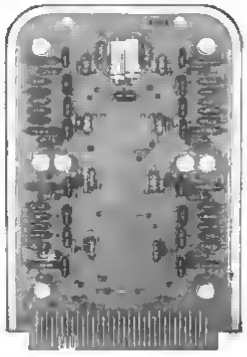

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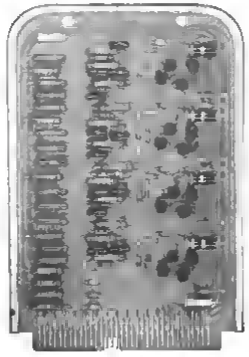

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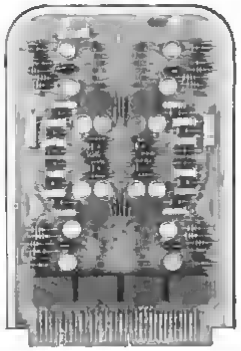

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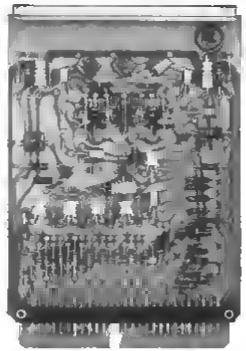

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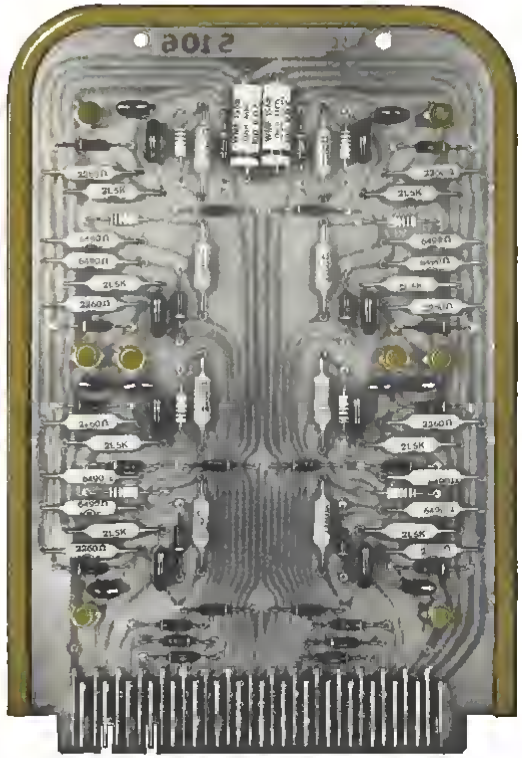

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Cessna Acts to Widen Twin-Engine Sales; Foresees Industry Growth

New York—Major business aircraft manufacturers are moving toward a stage of direct model-by-model competition throughout their entire product line, Dwane L. Wallace, president of Cessna Aircraft Co., believes.

For its part, Cessna is going after a larger share of the twin engine market where its 25% sales share trailed the 51% unit volume mark it recorded last year in the single-engine class, Wallace told the New York Society of Security Analysts.

Introduction of the Model 336 Skymaster (see p. 88) will have some impact this year, he said, and a much greater one in 1964. Following the Skymaster will be a six-place high performance airplane, the Cessna 411, designed to sell for $105,000-$110,000 and fit between Cessna's Model 320 Skyknight and the Beech Queen Air and the Aero Commander families.

Significantly, Wallace said, the business aircraft roster has grown from eight single-engine and three light twin models to 23 single and 14 twin engine models in the last 10 years, but introduction of new airplanes has not greatly disturbed the market share of established airplanes.

Cessna's Model 310 had no direct competition when it was introduced and for three years preceding introduction of a competitive airplane—the Beech Travel Air later joined by the Baron—sales averaged 200 annually. In the two years that followed the 310 average rose slightly to 208 per year. Three years ago, Wallace continued, the Piper Aztec entered the market but Cessna's average annual light twin sales figure rose to 242. The total middle sized twin average annual market has grown from about 200 units to 675.

"Similar examples can be found in other aircraft," Wallace said. "The Beech Bonanza continued to sell in the face of new competition by our 210 and Piper's Comanche. The market also absorbed the relatively recent Piper and Beech entries into the low-priced field so long dominated by our Model 172.

Wallace said that a recent Cessna market survey indicated that there are 395,000 business prospects in the U.S. for private aircraft based on size of business, income, per cent of budget spent for travel, and other factors. Another manufacturer's survey developed a 400,000 prospect figure. Degree of market penetration is relatively low.

"In the broad general business classification of transportation communication and utility firms, we find there are 120,000 such firms which, in the aggregate, own 11,970 aircraft," Wallace said. "We do not suggest that all of these 120,000 firms are prospects, but we do estimate that approximately half—or 60,000 of them—are bona fide prospects. This means we have a market penetration of only about 20% in this category.

"A similar situation exists in the extraction category which covers mining, oil industry, etc. Here, there is a total of 15,500 firms which are bona fide prospects, of which 690 use aircraft or a 4.4% market penetration. In the broad category of manufacturing, there are 11,190 airplanes being used among a group of 145,000 bona fide prospects for a 7.7% penetration."

Pleasure flying—including a 45% class of owners who use their aircraft for both business and pleasure flying—has 407,000 prospects, Wallace said. This group owns 19,720 airplanes, leaving a market penetration of 4.8%.

It is interesting to note," Wallace

Cessna Writeoffs

Cost of getting out of the helicopter business—half of it for the buying back of 20-25 CH-1 Skyhook commercial helicopters in the field—will be written off this year by Cessna Aircraft Co.

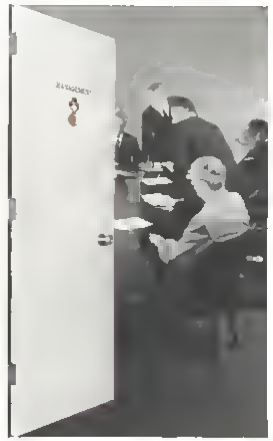
The cost, which does not include amounts Cessna has lost on its rotary wing program during the previous years it was active, will be about $750,000 net after taxes, according to Cessna president Dwane L. Wallace. Some operating savings will be effected by dropping the helicopter division, Wallace said lessening the impact on earnings.

"We had hoped to develop a commercial market and gain some military support," Wallace said. "We never got the military support and after 11 years we had not developed a commercial market. Our market surveys showed nothing but continued loss for the next four or five years, and they weren't sure of a market after that.

"There was no obligation that we buy back the helicopters. But we felt a moral responsibility. We've been in this business a long time. The more we thought of Cessna orphans in the field, the more we wanted to buy them back."





said, "that when the Curtis Report on Aviation was issued during the Eisenhower Administration, pleasure flying was projected to decline. Actually, Federal Aviation Agency figures show that pleasure flying increased 40% between 1958 and 1961, and now is expected to accelerate during the next five years," Wallace said.

Wallace raised objections to both turboprop and turbojet powerplant aircraft as a direction of expansion. A piston engine is one-third the cost per horsepower of a turboprop engine, Wallace said, and the turboprop requires a pressurized airplane for efficiency.

"The turboprop is coming," he said, "but we feel it's quite a way down the road."

On the market for pure jet business aircraft, Wallace added: "Our feeling is that the market for a $1 million or a $750,000 airplane is very narrow—for reasons starting with cost."

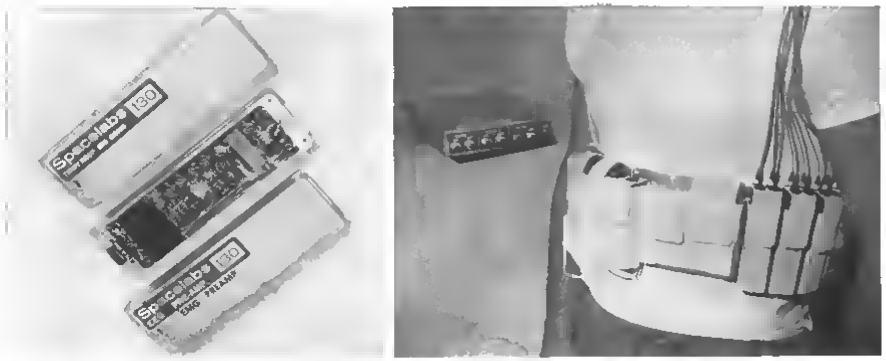
Airline Competition

This airplane is competing with the airlines where the airlines are at their best, Wallace said, and he feels the business airplane maker should cover the market that the airlines don't reach so intensely.

Other major points Wallace discussed:

- **Anti-trust investigation** of business aircraft manufacturing. Wallace said he had no word on its status, but Cessna has adjusted its distribution and merchandising practices to meet what the government investigators seem to have in mind.
- **Air Traffic control** problems for small aircraft. The instrumentation required situation is going to get worse, Wallace said, but not much worse, and improvement with development of better simpler instruments is on the way.
- **Sales and profits.** Cessna is hoping for a 10% increase in unit volume for its 1963 fiscal year and for some increase in earnings despite losses on its helicopter program. The first four months have been according to projections, Wallace said, but added that there are seven tough selling months ahead.
- **European competition.** European manufacturers need broader product lines to attract the necessary distributor-dealer organization. Such competition will grow, however, explaining Cessna's purchase of a 49% interest in Reims Aviation in France. A major market exists in less developed countries outside Europe, and a big help in developing this market would be a practical export financing program in the U. S., Wallace said.

The nations that could benefit most from air transportation are also the ones that are most beset by economic problems, Wallace said.



FORTIONS OF PRINTEO-CIRCUIT prototype of bio-telemetry system (left) include signal conditioners receiver and transceiver control station Size and weight will be reduced by cordwood construction in version now being built Physiological data acquisition voice communication belt pack is shown, right Transceiver control station is in background High-density packaging will reduce belt pack size

Apollo Bio-Telemetry System Developed

By Barry Miller

Van Nuys, Calif—Prototypes of the bio-telemetry and short-distance voice communications system which may be used for monitoring space suit environment and physiological responses of astronauts during Apollo spacecraft flights are being developed here by Spacelabs Inc for National Aeronautics and Space Administration's Manned Spacecraft Center, Houston Tex

The voice communications system would enable an astronaut investigating the moon's surface to maintain voice contact with an astronaut remaining in the Apollo Lunar Excursion Module (LEM) and with their control center on earth This could be done via an S-band communication link in the excursion module The entire portion of the system carried by the astronaut would be small light and unencumbering If packaged in its final flight version like these prototypes it would be carried in a belt around the astronaut's body

United Aircraft's Hamilton Standard Div , which has responsibility for the Apollo space suit (AW Oct 22 p 33) is expected to pick a contractor soon for the flight version of the bio telemetry/voice communications system to be incorporated into the suit Design specifications for the flight system and a prototype now being built by Spacelabs are nearly identical, both having been written by the Instrumentation and Electronics Systems Div of Manned Spacecraft Center

Spacelabs' new prototype system scheduled for delivery to NASA early this summer, is designed to provide the following

- **Two-way simultaneous voice** communications between astronauts or between astronauts and a ground control center through a spacecraft transceiver control station which offers outputs for and accepts inputs from the spacecraft's S band communications link
- **Transmission, reception** and recovery of physiological or environmental telemetry signals in their original form by command or a manual switch while two-way voice communications are in progress Typical types of data that can be monitored over the seven data channels of the system will yield electrocardiogram electromyogram body temperature environmental temperature suit pressure electroencephalogram blood pressure and possibly respiration by an impedance pneumograph (AW June 11, p 79)
- **Emergency voice communications** by switching the receiver frequency to that of the transmitter which operates on the spacecraft recovery frequency

The system will consist of a belt pack radio transceiver for each man (two under this contract) and a remotely located transceiver control station While intended primarily for voice communications, the belt pack will contain all of the signal conditioners amplifiers and voltage controlled oscillators necessary for picking up and processing seven channels of physiological and environmental data

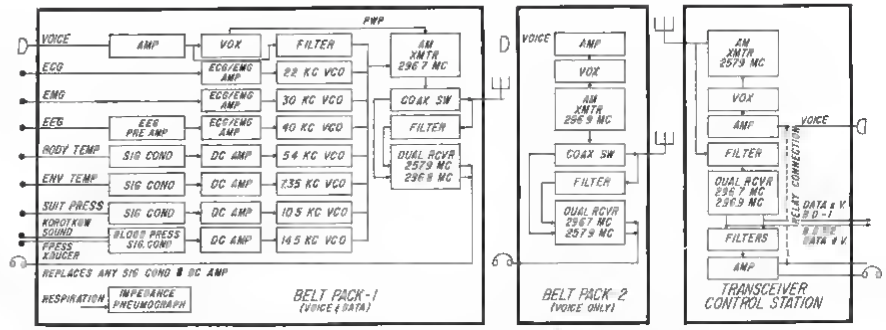
Inputs from sensors on the astronaut's body will be conditioned amplified and impressed on the oscillators whose outputs are mixed onto a 296 7 mc AM transmitter signal

Two modes of operation will be available for the system—a duplex operation, permitting simultaneous two way voice communications and simplex push-to-talk type of emergency communications between astronauts

In the duplex mode two astronauts may talk simultaneously through the transceiver control station and the spacecraft S band communications transmitter to the spacecraft control center, or one astronaut can talk while the other is sending physiological data One man will transmit on 296 7 mc the other on 269 9 mc , the 200 kc difference being sufficient to prevent the two signals from blocking one another out

A dual narrow band receiver in the transceiver control station will separately accept both signals and will be capable of routing both of the signals to the spacecraft communications transmitter

If one astronaut is not transmitting while his companion is, he can monitor two frequencies—that of the transmitting astronaut through a broadband 296 8 mc receiver in his belt pack and the 257 9 mc signal from the transmitter in the transceiver control station Should he then begin to transmit a relay filter combination on the first astronaut's belt pack rejects the other astronaut's transmissions



BLOCK DIAGRAM of new prototype biological telemetry and short-distance communication system is shown above System will permit astronauts to maintain voice communication with one another and provide technique for securing physiological and environmental space suit data during Apollo flights This type of system may also be used for lunar landings and later space missions

One astronaut can call the other via the transceiver control station if the second is talking, or he can talk directly if the other is not sending. Thus, one astronaut cannot break into another's conversation except through the transceiver control station

In a possible operational sequence the transceiver control station would be situated in the LEM with one astronaut at the station using a microphone and headset

The other man, surveying the lunar surface could remain in contact with his companion via his belt pack

The belt packs are battery powered (±14 v d c) as is the transceiver control station (28 v d c) Provision is made in the system for hardline wire link to replace the RF link when astronauts are together in the spacecraft

Spacelabs previously built a prototype belt-carried short distance communications and telemetry system for NASA Manned Spacecraft Center (AW Dec 4 1961 p 26), which was a forerunner of the version now in development The original version portions of which are shown in accompanying photographs, was also a seven channel system this one operating on 121 5 mc and using frequency modulation Its transceiver control broadcast AM signals on 72 9 mc The system was delivered to NASA last spring

FM Reception

The AM transmitter generated about 2 watts and despite the presence of a diplexer the AM transmitter tended to drown out FM reception

To minimize this problem, the new system will use amplitude modulation throughout

The initial prototype employed printed circuit board construction The belt pack weighed 5 6 lb , occupied 120 cu in of space, was too bulky to conveniently fit under a space suit The new prototype whose size and weight will be reduced through the use of a high-density welded packaging technique, will scale between 50 and 55 oz and occupy about half the volume of the original version

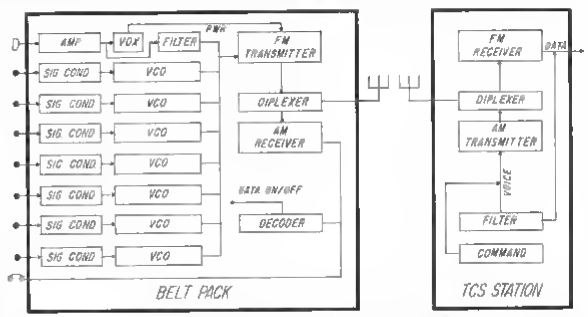
Welded Modules

Welded modules for the new system will be made in collaboration with Engineered Electromes Co in Santa Ana, Calif Typical modules will run about 1 in by 1 in by ¾ in and would contain the amplifier and signal conditioner for each channel The exception would be an impedance pneumograph, a device for obtaining respiration volume and rate by measuring trans-thoracic impedance (AW June 11 p 79) It would be somewhat longer than the typical module.

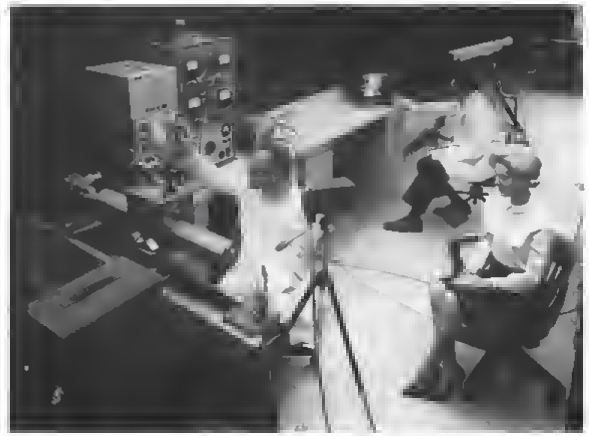
Each module will consist of conventional components, arranged in cordwood style with leads protruding through a Mylar sheet and then interconnected by ribbon They will be potted in an isocyanate polyurethane foam which has a 10 to 14 lb /cu ft density, about one tenth that of a normal epoxy compound, accounting for much of the system's weight savings

In the system being built, each transmitter, including that of the control station, will put out about 250 milliwatts as compared with two watts from the AM transmitter in the transceiver control of the first prototype This reduction in power level is being offset by the use of sensitive belt receivers, which will have sensitivities of about −96 dbm

The initial telemetry prototype, built here last year, was not intended by NASA to be a model of an operational system Rather, it gave NASA engineers a chance to familiarize themselves with likely problems and to develop system concepts of which the system now being built and the one to be fabricated for the spacesuit contractor are logical outgrowths



FIRST PROTOTYPE biological and voice communication system built for Manned Spacecraft Center did not permit astronaut to be interrupted on simplex mode if he were sending either voice or data to transceiver control station This was forerunner of the new system.



SCIENTISTS at North American Space & Information Systems Div. demonstrate transmission of TV pictures over laser beams modulated by interference modulator of a type which company says may be suitable for optical space communications.

TV Transmission on Laser Beam Demonstrated by North American

Los Angeles—Transmission of television pictures on a laser beam was demonstrated here last week by North American's Space & Information Systems Div.

The interference modulator made possible an information bandwidth of 17 mc. at 40% modulation with a power requirement of under two watts, a performance which North American says may be improved substantially with further refinements. It was developed with space applications as a primary goal.

The modulator is an adaptation of the Twyman-Green interferometer which makes use of a half-silvered half transmitting mirror which splits a parallel beam of light so that half is reflected through a lens onto a point while the other half is passed through a prism and then reflected to the same point.

In the NAA modulation process, the light beam output from the laser is focused by a lens and then split into two beams by a half-reflecting, half-transmitting mirror placed at a 45-deg. angle with respect to incident light, as in a Twyman-Green interferometer.

The resultant split beams are reflected back toward the beam splitter by mirrored piezoelectric transducer elements each of which is modulated by 180 deg. out-of-phase video signals. The impression of electrical signals on the transducers causes them to be displaced with respect to the beam-splitting mirror, thereby changing their path lengths to the center point of the beam splitter.

The beams then recombine constructively or destructively with an intensity proportional to the modulating signal. A second lens recollimates the modulated beams which are later detected by a photo cell in an optical receiver, converted back into TV signals and displayed on a TV monitor.

Each piezoelectric transducer in the modulator is biased 1 quarter of a wavelength onto the linear portion of the light beam's curve to insure a linear relation between output intensity and modulating signal.

Microcircuit Life Tests

Study to determine the catastrophic failure rates and the nature of deterioration of semiconductor microcircuits on accelerated life tests will be initiated soon by the Univac Div. of Sperry Rand.

Study will be conducted under a contract from the Navy's Bureau of Ships.

Univac will buy digital circuits of the types suitable for its operational control 667 computer. This is a large-scale military computer which is scheduled for use in naval strategic operations.

The microcircuits will then be subjected to life tests in an effort to accumulate the necessary life information.

FILTER CENTER

▶**Minuteman Microcircuitry Hits Snag**—Persistent industry reports that suppliers have fallen behind schedule in deliveries of microcircuits destined for feasibility guidance systems of the improved version of Minuteman ICBM have elicited a "no comment" statement from Autonetics Div. of North American, associate prime contractor for the missile's guidance and control system. Difficulty may stem from circuit designs hard to realize at the current stage of semiconductor microcircuit technology. These devices are expected to be a key factor in achieving dual goals of decreased weight (for range-payload benefits) and better accuracy in the improved Minuteman.

▶**Universal Space Navigation System**—Feasibility of developing a space navigation system, suitable for use in a wide range of military space vehicles by making only minor modifications to the system, has attracted serious interest at Air Force's Space Systems Div. A study of the navigation system's requirements reportedly is being conducted for Space Systems Div. by Massachusetts Institute of Technology.

▶**NASA Funds Decision Filter Effort**—The possible application of a parallel-logic, self-organized machine to the problem of interpreting cloud patterns will be investigated by Astropower Inc., under a $33,936 contract from NASA. The machine will be patterned after

Laser Rangefinder

Lightweight, battery-powered laser range finder, developed by Hughes Aircraft Co. has an accuracy of 5 yd. at a range of 7 mi. It can range successfully beyond 5,000 yd. on days when visibility is severely restricted. It has an optical telescope for sighting, uses ruby laser transmissions which are detected by a photomultiplier. NATO nations are reported considering adoption of laser range-finders for military field use against tanks and helicopters. Radio Corp. of America is developing the devices for Army Signal Corps and other companies including Raytheon and IRC, have built similar devices.

the company's decision filter (AW May 28, p. 58), a self-organized device that can recognize a series of three-dimensional objects.

▶ **Thin Film Active Element Program**—Army Signal Corps will sponsor a one-year research and development program in thin-film field effect transistors (AW Feb. 4, p. 68) and space charge limited triodes, the successful operation of which was reported recently by Hughes Semiconductor (AW Feb. 18, p. 97). Proposals for the contract are scheduled for submission to the Army next month.

▶ **Signed on the Dotted Line**—Among contracts recently awarded to avionics companies are the following:

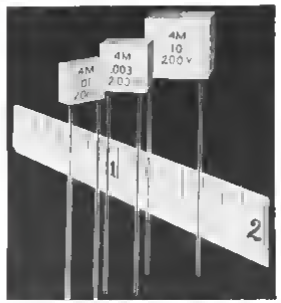
• **Lockheed Missiles & Space Co.** will continue research and development of a spin echo computer memory for the Office of Naval Research.

• **Westinghouse Electric Corp.** will develop and fabricate high and low resolution image intensifier panels composed of electroluminescent and photoconductive elements for the Naval Training Device Center.

• **Thompson Ramo Wooldridge** will investigate a high current density electron bombardment ion engine under a $150,000 contract from NASA's Lewis Research Center.

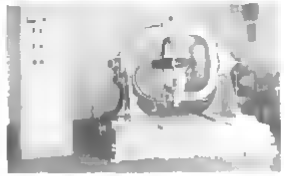
NEW AVIONIC PRODUCTS

• **Micro-metallized Mylar capacitors** in rectangular cases for printed or welded-circuit use, operate over temperature range of −65C to 125C without voltage derating. Units are available with 200 v. rating in 0.001 to 10 mfd. sizes and



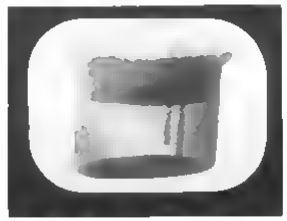
are designed to meet environmental requirements of MIL-C-14157B, MIL-C-19978B and MIL-C-18312B, according to manufacturer. Bulletin 81662 gives application data. Manufacturer: San Fernando Electric Mfg. Co., 1509 First St., San Fernando, Calif.

• **Three axis flight simulator,** Model S-450A, operated from analog computer or function generator, provides minimum rates of more than 700 deg./sec. and minimum rate of less than one-



tenth the earth's rotation rate. Angular accelerations of more than 50,000 deg./sec.² can be obtained with frequency response to beyond 27 cps. under rated load. Simulator has been purchased by McDonnell Aircraft Corp. for use in Gemini program, according to manufacturer. Circo Electronics, 1180 O'Brien Drive, Menlo Park, Calif.

• **X-ray sensitive vidicon camera tube,** Model ML 589, which can be used to see through metal to detect internal flaws in transistors and other components, measures 1 in. dia. x 6 in. long. When irradiated by adequate X-ray source in a modified closed-circuit television system, tube can be used to see



through steel casings and weldments up to ½ in. thick. Detailed resolution exceeds 0.001 in. and image quality is comparable to fine-grain, high contrast radiographic film making new tube suitable for magnifications up to 50X, according to manufacturer. Machlett Laboratories, Inc., 1063 Hope St., Springdale, Conn.

• **Silicon digital Micromods,** Series 2,000, a line of digital functions each in

rectangular package measuring approxi-

Published monthly by Giannini Controls Corporation: 1. In self-recognition of our unusual Measurement and Control capabilities for Aerospace and Industry. 2. For painless, incremental reading. 3. To advance our belief that the truth need not be dull.

POTPOURRI

EDITORIAL

FREE STREAM MEASUREMENT PROBE

(photo enlarged 10,000 times)

Once upon a time there were two ways to check flowing stuff; you stuck a probe into it or you grabbed some as it went by. Either way—stab or grab—you ended up making an accurate analysis of a non-representative sample (where you touched the flow, creating turbulence, you changed its character).

Now there's a better way. Giannini Controls, in its lust for measurement accuracy, has developed a new type of probe. It senses free stream data without making waves. *Our probe is a beam of gamma rays.*

Say, for instance, you want a precise, direct measure of air density from a sounding rocket. As a start, put a tiny radioactive source inside the rocket's skin. The source shoots a beam of gamma rays off to the side of the bird. Elsewhere on the rocket put a Giannini densitometer and focus it on the gamma beam. Then crank up your bird and fire it. It's just that simple. Honest! (doubters can find more intimate details in the far right hand column)

NEW PRODUCT OFFERED

PENDULOHM

A NEW VERTICAL DEVIATION SENSOR

Giannini's Pendulohm is a precise, pendulum potentiometer. It is extremely rugged, hermetically sealed, versatile, inexpensive, and meets MIL-E-5272C. Tilt range is ± 10 to 45°. Response can be controlled by oil damping, depending on specific use. Applications include: Platform stabilizer, pitch-roll control, torpedo attitude control, vertical sensor, artificial horizon transducer and zero sensitive accelerometer.

PERSONAL

ALLES GUTE ZUM GEBURTSTAG, WERNHER*

*(Want to wish Dr. Von Braun happy birthday [March 23]? It's easy. Just cut out the rectangle above, sign your name, and send it to him in Huntsville)

CORPORATE ADV

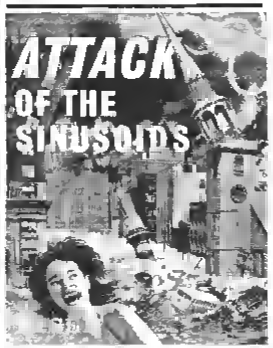
Giannini Controls Corporation

1600 S. Mountain Ave., Duarte, Calif.

TEST YOUR COUNTER-ESPIONAGE SKILL

Hidden in the illustration above are five dastardly enemy agents (Madame X does not count). Normally suspicious people should be able to find all five in about 30 seconds. Mathematicians and social workers may take a little longer. If you solve it in 10 seconds or less, you might well consider being sneaky for a living.

BOOK REVIEW



ATTACK OF THE SINUSOIDS

by Jim Kyser, publ. GCC, 1962

We're kidding with the title and the picture above. Jim Kyser, however, isn't kidding when he writes of sinusoids. In his latest paper, *Experimental Servo Analysis*, he shows how they can be used to determine the stability of any closed-loop system from its open-loop frequency response. We quote: *In closed-loop system design, experimental frequency response data can be interpreted directly in terms of the design changes needed in a particular physical system. No elaborate data analysis is required.* Neat trick, saves time, saves money.

Want a copy? See below.

EDITORIAL (continued)

As we left our hardy band of adventurers two columns to the left, they were in the act of firing their Giannini equipped sounding rocket in hopes of achieving an accurate, direct measure of true air density. As the rocket soars into space, a beam of gamma rays is directed through the skin of the bird. The gamma, interacting with the air, scatters. The ratio of the gamma scatter is in direct proportion to the density of the air. The watchful densitometer, which is zeroed in on the gamma beam, counts the rate of scatter—allowing a direct running account of air density to be made. It works on the ground—it works at 250,000 feet, it even works during re-entry (gamma rays penetrate plasma like it wasn't there).

For more complete facts about sensing air data at hypersonic velocities, write to our Dept. W.

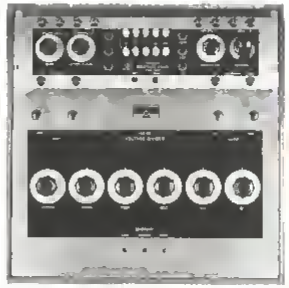
INFORMATION

MORE POOP

For more data about anything mentioned on this page drop a line to GCC, 1600 S. Mountain, Duarte, California.

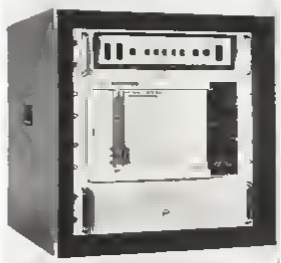
mately ¼ x ¼ x 0.172 in. can be operated at speeds up to 15 mc over temperature range of —55C to 125C. Power consumption is 40 mw. Circuit functions available include inverter, steering circuit, AND/OR gate, clock AND gate, emitter follower and supplemental gates. Manufacturer: Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif.

• **Primary resistance standard** measuring system, Model PRB 2056, permits measurement to accuracies of 0.0005% re-



ferred to National Bureau of Standards units, according to manufacturer. Device incorporates a primary multiple resistance and voltage divider standard which are individually certifiable by NBS. It covers five resistance ranges from 1,000 ohms to 10 megohms, with measurement resolution provided to six digits. Manufacturer: Julie Research Laboratories, Inc., 211 West 61st St., New York 23, N. Y.

• **Statistical digital voltmeter,** Model SV2, measures data in electrical form, classifies and plots it in form of a frequency distribution graph (histogram),



within 30 sec. after operator pushes readout button. The histogram shows number of items falling within, above and below preselected tolerances or the number of items which have fallen into any one of 16 other specified categories above or below a center value, and how these data compare with a previous period. The device measures and classifies input voltages to an accuracy of 0.01% in three ranges up to 1,000 v. Manufacturer: Non-Linear Systems, Inc., P. O. Box 728, Del Mar, Calif.

• **Pliable magneto-resistive element,** known as MisloR, can be conveniently attached to curved as well as flat surfaces using epoxy cement. The thin film magneto-resistive elements, with output signals in the range of 5-10 v., are available with resistance values of 100 to 10,000 ohms. Manufacturer: American Aerospace Controls, Inc., 123 Milbar Blvd., Farmingdale, N. Y.

• **Portable radar performance analyzers,** transistorized, provide minimum discernible signal measurements on pulse compression, matched filter, moving target indicator and conventional radar systems. Analyzers are available with interchangeable RF heads to cover frequency range of 200 mc. to 5,900 mc. Manufacturer: Sperry Microwave Electronics Co., P. O. Box 1828, Clearwater, Fla.

CESSNA MODEL 336 SKYMASTER features tandem-mounted Continental IO 360 A engines and a twin-boom tail arrangement.

CESSNA SKYMASTER'S REAR ENGINE has a shaft-mounted fan to augment cooling air flow.

Aviation Week Pilot Report:

Tandem-Engine Cessna Skymaster Offers Flying Ease, Simplified Pilot Transitioning

By David A. Brown

Wichita, Kan.—Exceptional engine-out performance, handling characteristics similar to contemporary single-engine aircraft and a cabin sound level equal to or quieter than conventional light twin-engine aircraft are the outstanding qualities exhibited by the Cessna Model 336 Skymaster, a light twin with tandem-mounted engines.

Skymaster, flown here recently by this AVIATION WEEK & SPACE TECHNOLOGY pilot, proved itself to be a single-engine pilot's airplane from taxi to landing.

Among the capabilities demonstrated were:

- **Single-engine takeoffs** from a standing start using either front or rear engine.
- **Landing characteristics** similar to Cessna's single engine line of aircraft.
- **Lack of stringent piloting** requirements. This should permit present single engine rated pilots to transition into the Skymaster in a maximum of 10 hr. flight time.

In addition, the Skymaster showed itself to be a responsive, easy airplane to fly. The cabin noise level permitted normal conversation even when both engines were delivering maximum power outputs.

Aircraft flown, N 1703Z, is the third production model of the Skymaster and has been assigned to Cessna Senior Vice President Del Roskam to evaluate from a customer standpoint. Dwane Wallace, Cessna president, also has a Skymaster for personal evaluation. Roskam, heretofore a single-engine pilot, has received the first of the new centerline-thrust, twin engine pilot ratings created by Federal Aviation Agency for the Skymaster.

William D. Thompson, Cessna chief of flight test and aerodynamics, flew in the right seat.

Walk-around inspection on the Skymaster is similar to that on other aircraft of its class. Four under-wing fuel drain points are operated with a fuel drain cup provided with the aircraft, which has a metal probe extending from the bottom of the plastic cup upward. Probe is inserted in the fuel drain ports and pressed upward to open the spring loaded valves. Fuel drains into the cup.

Drain ports are located in the forward lower section of each wing boom, where the sump tanks for the main fuel system are located and under each inboard wing section where the low points of the auxiliary tanks are located.

Access doors below shoulder height open in the front and rear engine cowlings to reveal oil sump dipsticks and pull knob for the fuel strainer drains on each engine.

Control surface freedom was checked. Flaps were checked electrically after the master electric system switch was turned on.

Skymaster has a single entry door on the right, forward of the leading edge of the wing. Door is 36 in. wide and provides access to both front and rear seats. Smaller baggage and cargo door, also located on the right side of the fuselage, is aft of the second row of seats and allows baggage to be loaded in the rear of the cabin.

Cargo door measures 19 in. wide by 21.5 in. deep. Cargo area also can take two additional seats to make the Skymaster a five- or six-seat airplane.

All controls, switches and levers have been moved from the Skymaster's cabin floor to facilitate entry to the left front seat. In addition the sub panel below the instrument panel has been recessed approximately 1½ in. and tilted back 38 deg. to the main panel. This provides ease of vision and increased leg room.

Production Skymaster has conventional twin-engine lever-type engine controls, which replace the original push-pull, vernier-type. Original system of dual vernier proved difficult to manipulate.

Flight instruments are grouped in front of the left seat. Engine instruments are located in front of the right seat, with the three operating gages—tachometer, manifold pressure and mixture fuel flow—stacked vertically toward the center of the panel to be most easily visible from the left seat.

Center of the panel has space for four radio packages and an audio switch panel at the top, stacked above the center control console, which contains engine controls, yaw trim and autopilot. Space for a fifth panel-mounted radio is available at the extreme right.

Engine controls, left to right, are conventional throttle, rpm., and mixture controls, with the left control in each pair operating the front engine and the right control operating the rear engine. Engine control friction adjustment is on the right side of the console.

Left sub-panel contains master, generator and auxiliary fuel pump switches, magneto-start switches, engine heat controls, lighting switches and rheostats and the pitch trim wheel. Right sub-panel contains electric flap switch and flap position indicator, pre-position type cowl flap controls and heating switches.

Circuit breaker panel is on the left cabin wall just below the sub panel level and convenient to the pilot. Circuit breakers are of the pop-out type. Parking brake T-handle is located on the extreme left, beneath the sub panel.

Instrument and sub panel lighting is by means of four white lights spaced along the top front of the panel's glare shield. Lights are covered by sliding red lenses. This enables the pilot to have all white, all red or a mixture of white-red lighting. Three similar lights are mounted on the recess angle of the left sub panel and are optional as are post lights on the main panel. Right sub panel has only the integral lighting in the flap position indicator.

Notable features of the panel are the location of the pitch trim, which can be operated with the pilot's right thumb while his hand is on the throttles, and the pre-position type cowl flap controls.

Cowl flaps for both front and rear engines are electrically operated by twin control knobs which slide in a vertical track. When the knobs are fully down, both flaps are closed and vice versa.

Controls may be moved to any position along the track and the cowl flaps automatically assume a similar position in relation to full open or full shut. When the rear engine cowl flap control is moved to ¾ open, for example, the cowl flap will move to that position.

Basic flight instruments are located on the extreme left where they are somewhat difficult to see, particularly from the right seat. Thompson said they are considered emergency instruments only, however, and that the cockpit is tailored to one pilot operation.

Manifold pressure gage was confusing. Front needle, the one nearest the pilot, indicated manifold pressure for the rear engine. Rear needle, the one nearest the dial face, indicated pressure for the front engine. Considerable difficulty was encountered in correlating this front needle-rear engine, rear needle-front engine arrangement with the left throttle-front engine/right throttle-rear engine console setup.

Needle arrangement was reversed on the prototype Skymasters. It was changed because development engineers felt the present arrangement to be less confusing. Layout still is under study. By contrast, the split-dial tachometer (see photo, p. 95) is excellent.

Start procedure for the two 210-hp. Continental IO-360-A engines was simple and differs little from that of other light twin-engine aircraft. Master and alternator (generator) switches were turned on, mixture and rpm. controls placed in the rich and high positions, respectively, and the three-position auxiliary fuel pump switch turned to high. The throttle of the engine to be started was advanced about an inch, and the magneto-starter switch was turned to the start position.

Rear engine normally is started first since the pilot has to rely mainly on his hearing to determine when it catches. After the engine has started, the auxiliary pump is turned off.

Parking brake can be released by depressing the toe brakes and pressing the release button in the center of the parking brake T-handle.

Pilots accustomed to conventionally arranged twin-engine aircraft with asymmetrically mounted engines will find taxiing the Skymaster frustrating since turns cannot be made by using differential engine power settings.

Taxiing is similar to the procedure with a single-engine aircraft. Short-radius turns can be made by using differential braking and nose gear steering. Nose gear is steerable through 15 deg. either side of center and can turn freely to 39 deg. either side of center.

Engine run-ups consist only of check-

ing the magnetos at 1,700 rpm and exercising the two McCauley constant speed full-feathering propellers twice each. Propellers are mirror images of each other, since one is a tractor and one a pusher, but otherwise are identical. Fuel selector valves are on the cabin roof immediately between and above the pilots' seats. Normally the right main tank feeds the rear engine and the left main tank feeds the front engine, although it is possible to switch either engine to either tank. Fuel flows from the main tanks located in the outboard wing sections immediately outboard of the tail booms to small sump tanks in the lower forward portion of each tail boom near the wing leading edge. Sump tanks hold about 1 gal of fuel and at normal attitudes only about ¾ gal in each sump is unusable.

Auxiliary pumps are located in the leading edge of each inboard wing section and pump fuel into the fuel selector valves where it can be routed to either engine. Auxiliary fuel tanks located in the inboard wing sections empty directly into the selector valves by gravity.

When the auxiliary pumps are inoperative, fuel from the main tanks flows around the pumps and into the selector valves.

Engine-driven fuel pumps supply fuel to the engines. Vapor return lines permit fuel vapor from the front engine to return to the left tank and from the rear engine to the right tank. Fuel return in cruise configuration is about 5.6 gph.

Engine heat is not checked during run-up since the engines have fuel injection. Takeoff was made into a 15-mph wind with the temperature at 45F. Gross weight at takeoff was 3,281 lb, compared with a maximum gross weight of 3,900 lb.

Flaps were depressed to 30 deg., their

WIDE-SPAN SLOTTED FLAPS on the Skymaster's 201-sq ft wing give it a power-off stall speed of 60 mph. Wide-chord, short-span Frise-type ailerons are used.

CONTROL CABLES are routed up the Skymaster's wing strut to wing and tail booms.

maximum, and the throttles were advanced to full power. Acceleration of the Skymaster was rapid and the takeoff run was marked by a noticeable absence of yawing tendency. Contra-rotating propellers eliminate torque or differential slipstream pressures so that the Skymaster has little tendency to wander during the takeoff roll.

Rotation speed is 85 mph. It was necessary to pull the airplane off the ground with back pressure on the control wheel. This was true on every takeoff, regardless of flap setting. Takeoff roll distance was approximately 600 ft., and the aircraft crossed the far end of the 2,300 ft runway at about 400 ft. altitude.

Engines were throttled back to 2,500 rpm and 25 in. Hg manifold pressure. The Skymaster was turned away from the congested traffic area around McConnell AFB.

First impression of the Skymaster, and one that carried through all flight regimes, is that it feels in flight like a single-engine aircraft. Average pilot will not get the impression that he is in an airplane that can "run away" from him.

Once clear of local traffic, throttles were advanced to their limits and engine revolutions were increased to 2,800 rpm. to check climb characteristics. The Skymaster climbs at a slightly greater nose-high attitude than most light twins, but the attitude is not uncomfortable, and over-the-nose visibility remains adequate.

On two engines the Skymaster exceeded its design rate of climb by a fairly good margin. At 4,000 ft., 97 mph indicated airspeed (IAS) and with an outside air temperature (OAT) of approximately 50F, the aircraft climbed at an indicated 1,250 fpm. Design rate of climb at full gross weight, 5,000 ft. and 41F OAT is 1,010 fpm.

Rear-engine cooling, which was one of the major problems in the development of the Skymaster and one of several which caused the market introduction to be delayed a year, proved to be adequate in climb configuration provided the electrically operated cowl flap (actually an air scoop atop the rear of the fuselage) was used properly.

Flaps normally were opened on both engines during climb, takeoff and landing and closed during cruise. Engine cooling, both front and rear, is more than adequate for the conditions encountered at Wichita.

Skymaster maneuvers easily in climbs and the rate of climb does not fall off greatly during climbing turns.

Aircraft was noticeably more sluggish during single-engine climb, but still equaled or exceeded its advertised performance on both front and rear engines. Design rates of climb under the same conditions as those encountered during twin-engine climb were 170 fpm on the front engine and 225 fpm on the rear engine.

Skymaster was able to hold almost 300 fpm on the rear engine and approximately equaled its design rate of climb on the front. Since a continuous climb was being maintained, design climb rates were decreasing to compensate for the increased altitude.

In all single engine operation, the aircraft performed noticeably better on the rear engine than the front. There are a variety of reasons for this, chiefly that there is no large body to intrude into air flow from the rear propeller. Also the rear propeller tends to create an air sink, or low pressure area, which pulls air across the fuselage and lowers fuselage drag.

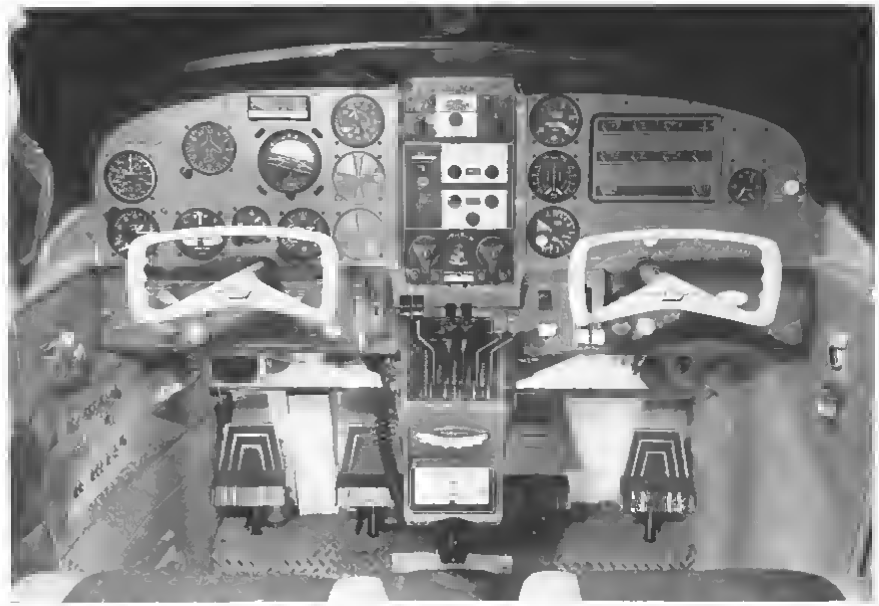
Finally, with the front propeller inoperative, the air stream encountered by the rear propeller is relatively less than it would be otherwise, and the greater differential in air stream speed on the two sides of the propeller disk means greater thrust is generated.

Power-off stalls were exceptionally gentle for a twin engine aircraft, with the stall warning horn sounding at 85 mph and the aircraft breaking cleanly forward at 70 mph. Still buffet was almost unnoticeable.

Power-on stalls with the engine operating at 2,300 rpm and 21 in. Hg man.

Skymaster Performance

Maximum speed	183 mph
Cruise speed, 75% power	173 mph
Range, standard fuel	890 mi
Range with aux. fuel	1,240 mi
Rate of climb, twin engine	1,340 fpm
front engine	355 fpm
rear engine	420 fpm
Service ceiling, twin engine	19,000 ft
front engine	8,200 ft
rear engine	9,500 ft
Takeoff over 50 ft obstacle	1,145 ft
Landing over 50 ft obstacle	1,395 ft
Stall speed, power off, flaps down	60 mph



INSTRUMENT PANEL HAS SPACE for five radios and has engine-out warning lights mounted atop rpm. controls on center console. Skymaster flight instruments are on the left, engine instruments on the right. Blank spaces at left center of the panel are for ILS indicators.

fold pressure, were more like those of conventional twins, with a very obvious buffet coming prior to the stall. Warning horn sounded at about 80 mph. and the aircraft stalled at 70 mph.

Skymaster consistently fell off on the left wing during a series of power-on stalls, but aileron control remained effective through the stalls. It was possible to obtain positive roll control completely through the stall.

Stall recovery was prompt and required only the release of back pressure to regain flying speed. Altitude loss was minimal even though the control wheel was held back until the nose was falling through the horizon.

Again, the Skymaster gave the feel of a single-engine aircraft in stalls and during slow speed flight. Single engine pilots should have no trouble in transitioning. Cessna's estimate of 5-10 hr. transition time possibly is conservative. Current single-engine pilots may be able to check out in the Skymaster in as little as 3-5 hr. flight time.

Slow flight characteristics, with full 30-deg. flaps, 2,100 rpm. and approximately 12 in. Hg. manifold pressure, proved good. Aircraft was fully controllable at 70 mph., and there was no tendency for the aircraft to get mushy on the controls.

Speed checks indicated that Cessna's claims for the Skymaster are conservative at lower power settings, but the aircraft fell slightly short of maximum design speed.

At 7,500 ft. pressure altitude with a 50F OAT, 2,800 rpm. and full throttle, the Skymaster held steady at 158 mph. IAS or 177 mph. true air speed (TAS). This was approximately ½ mph. under the design speed for these conditions and represented the only instance where the Skymaster failed to exceed design specifications.

At 71% power—21 in. Hg. manifold pressure, 2,500 rpm. and the mixture leaned to 10 gph.—the Skymaster indicated 154 mph., or 172.5 mph. TAS, about 3 mph. over design speed. At 63% power—21 in. Hg. manifold pressure, 2,300 rpm. and 9 gph.—the Skymaster flew at 148 mph. IAS or 165.5 mph. TAS, 6.5 mph. above design speed.

Cessna has not calculated design speed for single engine operation, but the Skymaster showed good speed performance on both the front and rear engines, although again, rear-engine performance exceeded that of the front.

At 2,800 rpm. and 21 in. Hg. manifold pressure, the Skymaster on the rear engine (inoperative propeller feathered in all cases) achieved a true air speed of 133.5 mph., with a fuel consumption of 13 gph. At 2,500 rpm., 20 in. Hg. manifold pressure and 11 gph. fuel flow, the aircraft cruised at 123.5 TAS.

Front-engine speeds were only slightly less. At 2,800 rpm., and 21 in. Hg. manifold pressure, the aircraft flew at 132 mph. TAS, with a fuel consumption of 13 gph. At 2,500 rpm., 21 in. Hg. and a mixture leaned back to 10 gph., the Skymaster flew at 118 mph. TAS. Outside air temperature was 50F during the speed checks.

Skymaster is most impressive in two flight regimes: single engine operation and landing.

Aircraft was designed to provide excellent single-engine capability, an objective which was adequately fulfilled. This coupled with the airplane's large wing area and impressive slow speed capabilities, give it excellent landing characteristics.

Pilot's seats are located ahead of the wing leading edge, so that the common fault of high wing aircraft, poor visibility of the airport while making traffic pattern turns, is not encountered.

Approaches were made at 100 mph. IAS at which speed flaps can be lowered. Flap extension speeds are 160

mph for the first 10 deg and 120 mph for the remaining 20 deg.

Flap extension is slow for the first few degrees of travel. Flap system brake tended to allow some coasting after the flap switch was turned off so that more flaps than intended usually were lowered. New flap brake is being studied.

Propellers and mixture were set for landing (props in high pitch and mixture full rich) and flaps were lowered 10 deg as the aircraft was turned onto the base leg. Wind was from the south at 13 mph with gusts to 20 mph.

Moderate re-trimming is required after initial flap lowering and somewhat less after flaps are depressed to 20 and 30 deg respectively. Flaps and elevator trim are mechanically interconnected so that it is not possible to trim the Skymaster excessively nose-high during a go-around or when making touch-and-go landings. Flap retraction automatically re-trims the aircraft to a lesser nose-up attitude.

Full flaps were lowered on final approach, and 90 mph IAS was maintained before touchdown. Thompson suggested that the first approach be kept at a relatively high altitude until the aircraft crossed the airport boundary. Power was kept on until the aircraft was over the threshold of the runway.

Skymaster has a faster sink rate with power off than Cessna's single-engine aircraft, but otherwise the aircraft's landing characteristics are much like a heavy-laden Model 182—so much so that landings will present no problem to transitioning pilots who are familiar with the company's lighter aircraft.

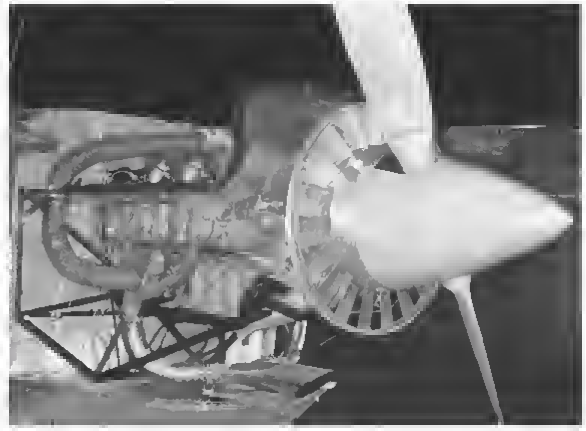
Aircraft was flared at 80 mph and touched lightly on the main gear. Steel-spring landing gear absorbed the landing force of the heavier aircraft without difficulty.

For immediate takeoff, it was necessary only to re-trim the aircraft nose down and apply power. The Skymaster accelerated rapidly and broke ground with its characteristic nose-high attitude after back pressure was applied.

Several twin-engine landings were made, and then the rear engine was killed by moving the mixture control to idle-cutoff and the propeller feathered by moving the rpm control rearward through a detent into the feather position.

Skymaster Dimensions

Length	29 5⅝ ft
Height	9 5⅝ ft
Wing span	38 ft
Wheel base	104 3 in
Tread	98 in
Gross weight	3 900 lb
Empty weight	2 320 lb
Useful load	1,580 lb
Wing loading	19 4 psf
Power loading	9 3 lb /hp



REAR-ENGINE COOLING is augmented by flange-mounted fan and baffle arrangement which directs airflow down across engine cylinders. Cantilever engine mount is used.

During single-engine landings and takeoffs, the Skymaster is most impressive. Yaw due to asymmetrical thrust is non-existent. Moreover, the Skymaster has the same approach characteristics in single-engine operation that it does with both engines turning over. Trim requirements are very nearly the same when flaps are lowered. Approach, over-the-fence and flareout speeds are the same, and the feel of the aircraft is only slightly different. Reduced acceleration is the prime difference with an engine out.

Single-engine landings were made with both front and rear engines and presented no difficulty. Primary adjustment is a psychological one caused by the sight of a feathered propeller in front of the cockpit.

Takeoffs—from a standing start—were made in both single-engine configurations without difficulty and without requiring excess distance to become airborne. Trim was set slightly nose up. Aircraft was rotated at approximately 85-90 mph and broke ground after a run of approximately 2,000 ft. Technique is the same as a twin-engine takeoff except that slightly more back pressure on the wheel is required.

Air starting of the engines is simple. When the rpm control is moved forward of the feather detent an accumulator allows the propeller to unfeather and windmill. Opening the throttle slightly permitted the engine to start after three or four revolutions. Air speed of approximately 120 mph is needed to rotate the rear propeller.

One final test—a rather hard landing—proved the structural integrity of the landing gear and the Skymaster's short field capability. It also demonstrated the difficulty of dragging the tail even in exceptionally nose-high flareout attitudes.

Aircraft, with 30-deg flaps, was kept high to avoid a power line near the field border, then nosed into the field and flared abruptly. Landing impact was noticeable, but the Skymaster had no tendency to bounce and the tail remained clear of the runway. The airplane stopped short without intensive braking and could have been completely halted in 700-800 ft from the runway threshold. Landing roll was continued with taxi power to clear the active runway.

Cessna has been remarkably successful in achieving the two primary design aims of the Skymaster project—single-engine performance superior to any other light twin now flying and greatly simplified pilot transition.

To achieve these goals, however, Cessna had to sacrifice some twin-engine performance with the result that the Skymaster is the slowest twin-engine aircraft in its price and weight range today. The company feels, however, that the advantages of exceptional single-engine performance and the ease with which current single-engine rated businessmen-pilots can adapt to the Skymaster's flying requirements will outweigh the loss in speed.

Finally, it is possible that a growth version of the Skymaster might have retractable gear, similar to the company's Model 210 which would increase cruise performance about 10% and make the Skymaster more nearly competitive in speed with its major rivals, the Beech Travel Air and the Piper Apache.

Cessna paid a cruise speed penalty of

15 20 mph to obtain fixed gear again reaching that the advantages of lower cost and greater simplicity would outweigh the performance sacrifice. Skymaster currently holds a price advantage over its two competitors.

Skymaster design came from studies initiated after a 1959 requirement was issued by the company management calling for a "light light twin-engine aircraft" featuring low cost, good single-engine performance and high single-engine service ceiling and a performance and load carrying capability competitive with other light twins.

Ease of pilot transition from single-engine aircraft also was a prime requisite since Cessna wanted to capture a significant volume of sales to pilots moving up to twin-engine aircraft from single-engine models.

Earlier Designs

No specific requirement for a centerline thrust design was issued however and a number of high- and low-wing configurations, with both tractor and pusher engine placement were investigated.

Most serious competitor to the tandem engine arrangement was what Cessna calls the "Uni-twin," in which two engines are coupled to the same propeller. Coupling, de-coupling and gearing problems, plus other troubles stemming from the need to place both engines immediately adjacent to each other, eventually killed this concept.

Tandem arrangement finally was selected as providing the best available compromise between the requirement for good single-engine performance and piloting ease and the need for competitive speed. Tandem configuration had been studied as early as 1957.

After the tandem configuration was approved in January, 1960 and a target date of early 1962 set for market introduction, detailed design work began. A variety of configurations again was studied, including both high- and low-wing versions. A low-wing aircraft with tandem mounted engines apparently is still under consideration by Cessna.

Prototype Work

Work on the first Skymaster prototype began in April 1960 and the first mockup was completed in July of that year.

First flight of the engineering prototype occurred Feb. 28, 1961.

Major changes included redesign of the inboard wing sections to change them from a tapered configuration to their present constant thickness and enlargement of the vertical tail.

Certification work was completed in May, 1962 and the first production-type aircraft was rolled out in August of that year. In March, 1962, however three major problems had arisen which caused considerable delay in introduction of the Skymaster. These problems included:

• **Lack of cabin area.** Management felt that the original Skymaster cabin, which held only four seats, was not large enough to compete effectively with other light twins in the price range most of which had 5-6 seat capacity. The cabin was redesigned and the rear firewall moved 5 in. aft, making it possible to include an additional row of two seats as optional equipment and increasing total seats available to six. This redesign was accomplished without moving the rear engine so that weight and balance problems were held to a minimum.

• **Insufficient rear-engine cooling.** Original underwing air scoops furnished air which was supposed to flow in over the top of the rear engine, then exit downward across the cylinder cooling vanes and out the rear of the engine cowling. Underwing scoops were eliminated and a variable opening scoop placed atop the fuselage above and immediately forward of the rear engine. Air flow now is directed downward across the engine cylinders by a baffle arrangement which deflects the flow downward and provides a horizontal seal along the sides of the engine compartment.

Cooling Air Ejection

Positive ejection of the cooling air is accomplished by a ring-shaped fan which is attached to the rear propeller flange and pulls air from the engine compartment. Drive shaft was extended 4 in. to allow for the fan wheel. Fan blades are 4.5 in. long and angled 25 deg. at the root and 20 deg. at the tip. They are mounted in a ring of built-up glass fiber and resin compound which is interwoven around the blades and then molded. Rear-engine cowling was redesigned to assist the positive air flow. A side benefit of this move was a lowering of production costs, since the new cowl design has proved cheaper to manufacture.

• **Noise problems in the cabin.** Cabin noise in the Skymaster prototype was disturbing, although it was not unusually loud when measured in decibles. A Cessna engineering team headed by Donald J. Ahrens, senior project engineer believed they faced a considerable psychological problem with the tandem engine arrangement anyway since they expected prospective purchasers to believe subconsciously that the airplane had to be noisy because of the engine placement. Major part of the sound reduction program centered around the rear cowling. Original cowling was found to be causing noise of a highly disturbing nature.

Change in the cowling shape to aid rear-engine cooling also changed the

nature of the noise generated and made the cockpit considerably more comfortable. Other noise reduction work included use of extra black mastic sound deadener and additional glass fiber insulation mats. Studies conducted by Cessna with production model Skymasters show that the present noise level is comparable to that in the cabin of a Model 310. Normal conversation is possible in flight, and the type of noise is virtually identical to that generated by other light twin-engine aircraft.

These changes slowed the project almost a year. Current schedule calls for dealer tours of Skymaster models to begin in April and first deliveries to be made in May. Price lists were issued only last week and first orders received Mar. 12. Roskam estimates that most of Fiscal 1963 production (through Sept. 30) will be demonstrator aircraft, with only a few going to customers.

Despite its radical appearance, the Skymaster retains many features found in previous Cessna aircraft and incorporates few unusual manufacturing or production processes. The aircraft bears a strong resemblance to other Cessna models, despite the fact that approximately 85% of the components are of new design.

Wing Design

Wing of the Skymaster is the largest on any Cessna aircraft in production, having a gross area of 201 sq. ft. Airfoil section is NACA 2412 at the root, tapering to an NACA 2409 section at the tip. Dihedral of 3 deg., constant from the fuselage to the tip, is used, and the wing is tapered from the outboard side of the tail boom attachment points to the tip.

Forward portion of the tail boom is an integral part of the wing.

Wings have two spars, built up of 2024 alloy I-sections with 2014 alloy extruded spar caps. Balance of the wing is 2024 alloy. Each main wing panel attaches to the fuselage at the front and rear spars and small carry through spar bulkheads in the cabin are used to allow maximum head room.

Main torque rib is located immediately outboard of the tail boom attachment point and the wing strut runs from that rib to the fuselage. Inboard wing area is of shear web construction and the outboard wing is of tension field design and cantilevered from the strut attachment point.

Spars are located at 20% and 65% chord points, with ribs of formed sheet alloy and stringers. Hat section stringers are used in the fuel bay areas. Main fuel tanks are located in two bays immediately outboard of the booms. Auxiliary fuel tanks are located in a single bay in the inboard wings, extending from 6 in. outboard of the fuselage to a torque rib located on the inboard side of the tail boom. Torque ribs also are located at the fuselage and at the outboard end of the main fuel bays. All are built up of T-cap extrusions and riveted web extrusion stiffeners.

Flush riveting is used forward of the rear spar for lessened drag and J-section stiffeners support the wing skin. Button-head rivets are used aft of the rear spar. Wing skin is of .025-in. thick sheet alloy along the leading edge, .032-in. over the inner (auxiliary) fuel bay, .020 over the outer wing fuel bays and .016 along the trailing edge and outboard wing panels.

Wing Lights

Wing tips are of glass-fiber construction and position lights are mounted in the tips. Plastic light tubes extend through the bottom of each plastic tip so the pilot can see if wing tip lights are operating.

Boom section of the wing is made of 0.25-in. thick alloy.

Frise-type ailerons 100% mass balanced and also aerodynamically balanced are hinged at the 70% chord line. Aileron, with 11.8 sq. ft. of surface aft of the hinge line and 3.64 sq. ft. forward of the line, tends to add drag to the low wing during a turn, which acts to counter skidding motion induced by the lowered aileron on the high wing. Each aileron has three hinge points.

Control arrangement consists of a chain and sprocket drive from the control wheel column to a cable, pulley and bellcrank arrangement which extends up the wing strut beneath the aluminum fairing and then through the leading edge of the wing. Bellcranks located in the leading edge of each wing, drive the ailerons through chordwise push-pull tubes. Bellcranks are adjusted to give a differential up-down travel. Ailerons move up a maximum of 21 deg. and down a maximum of 14.5 deg.

Roll Trim

The Skymaster does not have a cockpit controlled roll trim. Ground adjustable flush tab, held by three screws is built into the left aileron.

Slotted flaps, operating on tracks are located both inboard and outboard of the tail booms on the wing. Flaps have a total span of 21.92 ft. and a total deflection of 30 deg. Electric flap actuation motor is located in the rear of the cabin roof and powers a ball-bearing screw jack actuator which travels in a linear forward-back axis. Actuator operates the flap cable, pulley and bellcrank system, which extends through the fuselage wall into the wing and connects to a single bellcrank for the inboard flaps and to the inboard of two bellcranks for the outboard flaps. Two bellcranks for the outboard flaps are joined by a

VARIABLE-OPENING AIR SCOOP supplies cooling air to rear engine. Forward portion of the tail booms are integral parts of the wing panels on the Skymaster.

spanwise push-pull tube. Chordwise push-pull tubes extend from the bellcrank quadrants to the flaps

Mechanical flap-elevator trim interconnect works off the inboard bellcrank of the right outboard flap and consists of a flexible rod which extends into the right tail boom and is attached to a metal collar which encircles the elevator trim control cable. Control cable has a metal button swaged onto it which is prevented from excessive rearward travel when the flaps are up. When flaps are lowered, the flexible rod pushes the collar rearward down the elevator trim control cable and allows greater trim cable travel. Elevator trim is limited to a maximum of 10 deg travel if the flaps are in the 0-15 deg range.

If the flaps are raised with the elevator trim in a greater than 10-deg nose-up position, the interconnect system will pull the trim cable forward and automatically re-trim the aircraft.

Flap position indicator on the instrument sub-panel is electric and is actuated by a potentiometer connected to the flap linkage bellcrank. System measures actual flap motion to prevent incorrect readings.

Wing struts are single-piece aluminum alloy H-extrusions, which form a triangle with the main wing torque rob and spar and a single fuselage bulkhead. Struts furnish routing for all control cables except those for the flap system. Control cable guides, made of molded nylon, also form supports for the 020-in. thick aluminum fairings and allow the wing struts to be used as push points for ground handling. Fairings can be removed to adjust control cables.

Impregnated glass-fiber attachment fairings cover the strut attachment points at the fuselage and wing.

Tail booms and the horizontal tail form a bent type rectangular unit to aid in absorbing various loads. A heavy metal fairing 34.5 in. long on the outside of the booms opposite the stabilizer attachment points provides a smooth transmission of tail loads into the booms.

Elliptical Booms

Booms are elliptical and formed of two T-extrusions on the top and bottom which extend from front to rear. Formed bulkheads, extruded stringers and stressed .016-in. skin complete the unit, which is manufactured in vertical halves. Halves are identical except for inspection door locations.

Halves are riveted together, and the completed boom can be used in either the right or left position. Control cables, electrical wiring and plumbing are routed through the booms to the tail, and an attempt was made to have an equal number of cables in each boom. Rudder cables extend through each boom, elevator cables through the left boom and elevator trim cables through the right.

Tail booms are attached to the boom section of the wing by a row of screws. Finger gusset inside the boom provides a doubler in the boom at the mating area.

Horizontal stabilizer is of built-up two-spar construction. Spars are formed channel sections with extruded spar caps and sheet metal webs attached. Skin, .020-in. sheet, is flush riveted for smooth airflow both on the stabilizer and the elevator. Stabilizer construction is designed to absorb bending stresses from the booms and the vertical fins as well as its own vertical loads.

Elevator also has two channel-section spars, formed ribs and skin which varies from .020 to .016 in. in thickness. Rear spar, which forms the hinge for the trim tab on the right, is not a major load-carrying member, however. Skin thickness is increased to .025 in. on the left side where the elevator bellcrank attaches and the torque rib on the end has additional stiffeners. Elevator is attached to the stabilizer by four hinges.

Control Cables

Control cables are routed out the wing struts, down the left tail boom and attach to the elevator bellcrank inside the left vertical fin. Push-pull rod runs from the bellcrank to a forged balance arm which moves vertically in the fin and carries 4 lb. of lead weight on the free end to provide 100% mass balancing. Elevator also is aerodynamically balanced. Second balance arm and weight is located in the right fin and is identical except that it is not attached to a push-pull rod.

Elevator trim cables extend up the right wing strut and aft through the right tail boom and are connected to a screw jack actuator in the stabilizer. Linkage provides differential control to the tab so that its movement in the center of the trim tab travel range is relatively less per given travel of the cockpit control trim wheel than at the upper and lower extremes. This allows minute adjustments to be made in cruising flight, when only slight changes are desired and much larger trim adjustments during landings, when flap deflection causes nose-down pitching and requires correspondingly large nose up trim.

Vertical fins have differential sweepback above and below the tail boom. Upper fins are swept back at 40 deg and the lower fins at 52.5 deg. Two channel-section spars, formed ribs and stiffeners are used in fin construction.

Rudders are of smooth-skin construction and are 100% mass balanced by overhanging weights at the top, as well as being aerodynamically balanced. Rotating beacon is mounted on the right rudder overhang, and contoured glass-fiber tips are used both top and bottom on the rudder and vertical fin.

Control cables pass through both tail booms to bellcranks located in the horizontal stabilizer. Differential travel is provided by offset bellcranks so that rudders travel outboard 22 deg. and inboard 15 deg. This allows effective elevator area to be increased. Structural fairing joins the fin and stabilizer.

Rudder trim system is a bungee device that works against the nose wheel in flight and feeds forces into the rudder control cables. There is no trim tab on the rudders.

Fore and aft engine placement allows the Skymaster to have a rather boxy cabin interior, ranging in width from 44.25 in. at the front seats to 33.5 in. at the baggage compartment area.

Fuselage is made up of four basic sub-assemblies—front fuselage section back to and including the front door post, upper and lower center fuselage sections and a rear fuselage section. Fuselage sections are of double 2024 alloy channel sections, one inside the other, with the flanges of the outer channel section rolled in for stiffness.

One bulkhead installed vertically, serves as the carry through member for the front wing spar at the top and as the wing strut attachment point at the bottom. Second, installed at an angle slanting forward from top to bottom, is the rear spar carry through member at the top and the landing gear attachment point at the bottom.

Use of double channel-section rolled bulkheads allows the door and window posts to be kept to a minimum thickness. Window area, excluding the windshield, is 2,000 sq. in. Windshield is 1,700 sq. in. in area.

Stainless steel firewalls are located at each end of the fuselage, the forward one vertically and the rear one L-shaped and running down the back of the cabin and under the engine.

Engine mounts are of welded tubular steel and are mounted to the firewalls.

Rear mount is cantilevered out from the fuselage and designed so that at horizontal (fore and aft) loadings in excess of 12g, the two lower tubular spars will fail first and allow the engine to drop down and away from the cabin. This is to prevent the engine from being thrown through the rear firewall into the cabin in the event of a crash landing.

Tunnel section is contained below the floorboard of the cabin and runs the length of the Skymaster fuselage from firewall to firewall. Tunnel, which may be uncovered completely, carries engine controls wiring and plumbing.

Maintenance of the Skymaster should be considerably speeded by the variety of access doors and openings.

Both engines are located at or near shoulder height when the aircraft is resting in a normal three point position.

Skymaster is the largest plane in the current Cessna line to use the steel spring landing gear common to the single-engine aircraft in the line. Gear has been redesigned and made of thicker stock to support the additional weight of the aircraft. Main gear of the Skymaster is of ⅞ in. thick machined steel.

Engines are Continental IO-360-A six-cylinder, horizontally opposed with [illegible] Manifold pressure is limited to 26.5 in. Hg which produces maximum rated power of 210 hp. at 2,800 rpm for takeoff and 195 hp. at 2,800 rpm for cruise. Engine will not exceed its manifold pressure limitation above 2,000 ft. msl. Below that altitude, yellow arc on the manifold pressure gage warns the pilot.

Continuous flow fuel injection system is used and the fuel mixture control is integral with the engine driven fuel pumps. Fuel is metered both at the pumps which are located in the engine cooling air flow to help freeze out vapor, and at the throttle butterfly valve. Overhead induction manifold is used with no cross feed.

Oil radiator is located at the rear of the cylinders to prevent oil from congealing at low temperatures.

Microswitch located on the top of each engine senses movement of the engine fore and aft in the engine mount. Engine moves about .25 in. in its mount when power is applied. Switch operates a red light on the rpm control lever in the cockpit. If the engine moves rearward while the throttles are in a position calling for power, the red light comes on informing the pilot he has lost power and which engine is malfunctioning.

Light lessens the chances of the wrong propeller being feathered in the event of an emergency. Pilot otherwise would have only his engine gages to inform him of engine failure, since asymmetrical feedback forces do not show up in the rudder pedals.

Electrical system is 28 v.d.c. with power supplied by two 28 v., 30 amp. alternators, one working off each engine, and a 24 v., 17 amp. hr. battery. Battery is located in the front engine compartment.

Ammeter on the right side of the panel can be used to check performance of either alternator or the battery. Selector switch is located below the dial face. Voltmeter is used to show bus voltage.

Electronic equipment is located immediately forward of the instrument panel and an access door just forward of the windshield on the upper cowling surface provides entry to the electronics area as well as the rear of the panel and the control linkages.

Cessna offers the Skymaster in four, five or six-seat configurations. In the latter two, the trim line of the left rear main cabin window is extended to remove additional metal skin and a pop-out type window is installed to facilitate escape in the event of an accident.

Soundproofing consists of tape and fabric to seal cabin openings. Black mastic sound deadener is used to coat skin panels and firewalls and glass-fiber mats are placed on top of the mastic and immediately below the upholstery and carpeting.

SPACE SUIT ANALYTIC DEVICE (left) built by Applied Psychological Services, is shown installed at NASA's Manned Spacecraft Center in Houston. Six-channel physiograph in foreground indicates physical and emotional state of subject in the suit. Arc and graduated sliding rod for measuring work space extend over test subject in adjustable contour seat. Test administrator's console faces away from test subject. Task panel (right) shows symmetrically mounted switches and indicator lights for reaction time test and ILS indicator for psychomotor coordination test. Space Suit Analytic Device was designed and built under a $29,000 contract.

Device Will Test Space Suit Performance

By Ward Wright

Wayne, Pa.—Space suit testing apparatus, designed to evaluate suit performance by subjecting the wearer to a uniform series of tests, has been built for National Aeronautics and Space Administration by Applied Psychological Services here.

Tester, called Space Suit Analytic Device, was recently delivered to the Life Systems Div.'s Crew Equipment Branch at NASA's Manned Spacecraft Center in Houston, Tex. Device was designed and built under a $29,000 contract issued Aug. 1.

Apparatus will be put into immediate use evaluating space suits for the Gemini two-man orbital spacecraft program and later to evaluate suits for the Apollo lunar landing mission.

Part of NASA's suit evaluation program will lead to development of minimum standards for space suit performance. These standards would give industry a reference point from which to begin new suit design and an assist to engineers concerned with cockpit design and instrument layout of future spacecraft.

Analytic device utilizes a number of known psychological and physiological testing techniques combined with angular and circumferential measuring equipment to obtain data on suit performance. "Until now," Arthur I. Siegel, director of Applied Psychological Services, said, "no real standard of space suit performance has been available ... suits have been relatively informally evaluated."

Apparatus consists of three units: operator's console, physiograph and a seat and base assembly mounting oxygen bottles for breathing. Certain accessories needed for some tests remain to be constructed and delivered. These are scheduled for delivery Apr. 30.

When the device is complete, including accessories, it will measure the following parameters of suit performance:

- **Dimensions of usable work space** within the reach of an astronaut. Measurement is achieved by swinging a semi-circular arc, which can be attached to either side of the seat base assembly, just out of reach of the test subject. Clamped at right angles to the arc is a graduated sliding rod, which, when pushed by the finger tip, measures the greatest distance a test subject is able to reach. Work space can be measured by adjusting the sliding rod along the arc and moving the arc in different positions around the test subject.
- **Visual field.** Measurement of visual field also involves use of the arc and sliding graduated rod. In this test, numbered cards are attached to the tip of the sliding rod, which is set with its tip drawn up against the arc. The arc, which has been swung to the sides out of sight of the test subject, is advanced until the subject can identify the card. By adjusting the sliding rod along the arc, and bringing cards into view from different points, the entire visual perimeter can be plotted.
- **Angular movement of limbs,** trunk and neck. Device is furnished with a commercial accessory, the Leighton Flexometer, which is strapped to the limb being tested. The dials are set at zero and the limb moved until restricted by the limits of the space suit. A direct measurement in degrees of movement is obtained from the difference of the two dials' readings.
- **Palm flexion**—minimum closure of a gloved hand. Measuring device is a simple, graduated wooden cone. Gloved hand is closed and slipped over the cone for a reading.
- **Psychomotor coordination** as affected by suit design. Test utilizes a standard instrument landing system (ILS) indicator, whose cross-hairs can be driven off-center in a random pattern at the command of the test administrator. The test subject tries to center the cross-hairs for as long as possible with corrections applied through a right-hand control stick adapted from a helicopter. Total time when the cross-hairs are not centered is recorded as an index of the suit's ability to permit fine, coordinative movements. Same test subject would have to be used for a valid comparison of different suits.
- **Manual dexterity.** A standard Crawford Small Parts Dexterity Test, used in psychological testing, is furnished as an accessory to determine the suit's ability to permit manipulation of small objects. Test consists of transferring collars and pins from trays to a pegboard with tweezers, and locking screws in holes with a small screw driver. Time to complete the test is recorded.
- **Light manipulatory performance** and effort required. This component, due for delivery Apr. 30, will consist of a form board with 10 sockets for five different geometric solid forms. Device will be mounted on an offset roller tray that can be extended over the test subject's lap. Manipulatory performance will be measured by the time required to transfer forms to their corresponding sockets. Miniaturized switches buried in the sockets will activate a timer while the form is being transferred. To measure effort required, the geometric forms will each be provided with a self-contained pressure transducer, battery, microammeter and appropriate circuitry to gage impedance. Microammeter will remain at its maximum reading until recorded and reset by the test administrator. A table for converting amperes to inch ounces of pressure will be provided. Required effort reading is based on a hypothesis that grasp pressure is a function of necessary effort.
- **Manipulative area** required by a gloved hand. This accessory, also due for delivery Apr. 30, will consist basically of a rotary knob or a toggle switch installed at the end of a 5-in.-deep, 8-in.-dia. cylinder. A row of sliding indicator pins will be arranged around the circumference of the cylinder. These pins will be displaced by the gloved hand when operating the control. The pins will remain at the point of maximum displacement until reset after a performance profile is determined.
- **Freedom of movement** as reflected by reaction time in operating typical spacecraft controls. Typical controls consisting of four lighted push-button indicator switches, four toggle switches and two four-position rotary switches are mounted symmetrically on the back of the operator's console within the reach of each hand. Indicator lights are linked with all controls to indicate which control is to be activated.

Indicator light and timer are started simultaneously and remain on until the control is activated. Test administrator can record the time and start the next task or he can record the total time for a sequence of tasks. To prevent the test subject from memorizing the task sequence, the administrator has an almost infinite number of task combinations available.

Oxygen bottles mounted on the back of the adjustable contour-molded seat assembly, provide pure oxygen to be breathed during tests where desirable. The suit will be pressurized to 5 psi during tests.

Six-channel physiograph, built by E & M Instrument Co., Inc., of Houston, records the test subject's body temperature in the neck and groin, galvanic skin response, breathing rate, blood pressure and heart rate during tests.

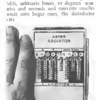
Physiograph evaluates the test subject's physical state and emotional response to wearing the suit. Siegel emphasized that after some experience with the analytic device, some channels of the physiograph may not be used. Some physiological indices may be found unnecessary for suit evaluation, but until then, the capability exists for a wide range of physiological monitoring.

Siegel says his firm is currently developing test procedures, data sheets, standard terms and scoring techniques to yield a precise, quantitative, objective profile of suit performance. The results will be compiled in a manual and furnished to NASA by Apr. 30.

NEW AEROSPACE PRODUCTS

Rapid Calculator

Device, called Astro-Addiator, quickly adds, subtracts hours or degrees, minutes and seconds and converts smaller units into larger ones, the distributor says.



A West German device, the Addiator is designed to speed sexagesimal computation and eliminate errors (computes in units of 60). Unit is available with green slides for use under red aircraft instrument lights at night.

Alexander Drafting Equipment Co., 640-642 North Chester Ave., Pasadena, Calif.

Explosive Reducer

Squib-actuated pressure reducer is designed as a control component for pneumatic pressurized systems in space.

Reducer will regulate a constant or decaying inlet pressure of 5,000 psi to

a factory-set pressure between 100 and 2,000 psi at the outlet. Unit will fit

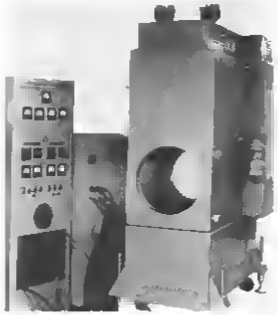
within a 1 in. x 2 in. x 5¾ in. envelope, has ¼ in. aircraft type ports and weighs 8 oz. Squib is fired by electrical impulse.

Pneu-Hydro Valve Corp., 52 Horse Hill Rd., Cedar Knolls, N. J.

Mobile Solar Simulator

Mobile solar simulator utilizes a combination of xenon and mercury-xenon lamps with infrared fill-in to approximate earth orbit and Venus orbit intensities.

Called the Type 147 Solar Simulator, both the earth orbit and Venus orbit models have collimated beams of uniform intensity and 1,000-hr. continuous operation capability, the manufacturer says. Simulator can irradiate a 12-in. area in both earth and Venus orbit versions and an 18-in. area in an additional earth orbit version. Collimation is within one degree on all versions, and intensities can be obtained with uniformity within 10% over the working diameter measured six feet from the exit port of the simulator. Simulator is 56 in. long, 37 in. deep and 71 in. high on casters. Center of collimated beam is 44 in. from the floor line.



Tenney Engineering, Inc., 1090 Springfield Rd., Union, N. J.

Pendulum Potentiometer

Humphrey CP17-0201 Pendulum Potentiometer can achieve substantial cost savings in certain target drone and torpedo pitch control applications where it can replace a vertical gyro, according to the manufacturer.

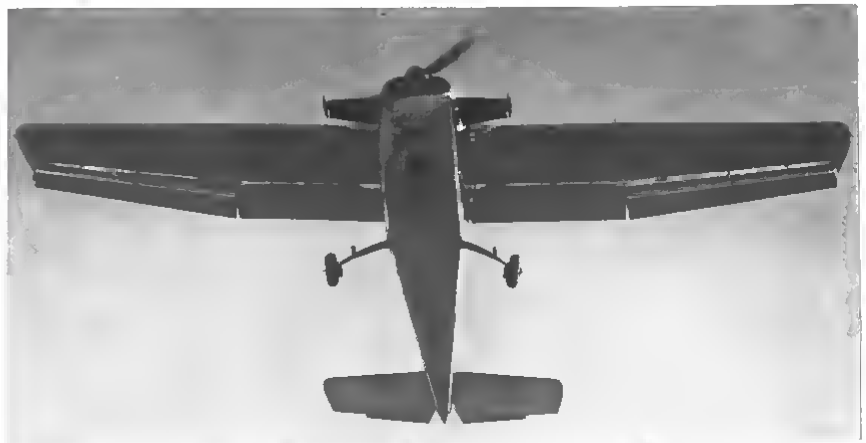
Range of the pendulum is ±45 deg. Output is obtained through a precision 2,000-ohm potentiometer that provides linearity of ±0.5% and a repeatability of 0.5 deg. maximum under dynamic conditions. Potentiometer has a center tap for a.c. or d.c. use.

Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.

Wren 460 STOL utility aircraft uses ultra low speed (ULS) nose mounted control surfaces to provide positive control slow flight regimes. Prototype aircraft is built around a 1958 Cessna Skyline airframe, but production models will use new Cessna 180/182 airframes.

Robertson STOL to Enter Market as Wren 460

Commercial development of the Robertson Skyshark (AW May 28, p. 89, Oct. 15, p. 23) entered Federal Aviation Agency certification flight test program recently. Aircraft is based on the Cessna 180/182 airframe, but has ultra low speed (ULS) control surfaces positioned in the propeller slipstream. Also added are full-span double-slotted Fowler flaps an 11-in. extension of the vertical fin and rudder and vortex generators atop the outboard wing panels. Fort Worth-based Wren Aircraft Corp. says the airplane can take off at gross weight in zero wind under standard-day conditions at sea level in less than 200 ft. land at 35 mph true airspeed in less than 100 ft. from a 20-deg. glide path and climb out at 15 deg. Positive control can be maintained with power to 26 mph. Engine is 230-hp. Continental O-470.



Climb-out attitude of the Wren 460 is relatively level. Note wing leading edge which has been modified to have a greater radius and a slight droop for stall control at slow speeds. Flaps are partially down for takeoff.

WHO'S WHERE

(Continued from page 23)

Honors and Elections

Edwin A. Link, inventor, has received the National Aviation Club's first Award of Achievement for 1963 in recognition of his invention and development of the Link Trainer and in appreciation of his outstanding contributions to pilot training and aeronautics.

Richard I. S. Deedler, a consultant with D'Orsay, Hurst & Co., has been elected president of The Wings Club, Inc., succeeding **T. O. Cocke**, senior vice president of Trans World Airlines. Elected vice presidents were **G. Marion Sadler** of American Airlines, **R. Dixon Speas** of R. Dixon Speas Associates, **Robert W. Tuttle** of Airlines Terminal Corp.

Dr. Louis Witten, of Martin Co.'s Research Institute for Advanced Studies (RIAS), has been elected a Fellow of the American Physical Society.

Barry W. Dames, director interline and military sales for Northwest Airlines, has been elected 1963 chairman of the Military Traffic Committee of the Air Traffic Conference of America, a division of the Air Transport Assn. of America. **W. Whitley Hawkins**, manager military and government transportation for Delta Air Lines, was elected vice chairman.

Changes

Robert O. Voight, director of ADAPT (Advanced Development and Planning Technical Center) Budd Electronics, a division of The Budd Co., Arlington, Va.

T. A. Boutwright, Jr., director of programs, Temco Aerosystems Div. of Ling-Temco-Vought, Inc., Greenville, Tex.

Dr. John M. Teem, technical director, Electro-Optical Systems, Inc., Pasadena, Calif., and **Dr. Henry L. Richter, Jr.**, manager, Advanced Systems Development Operations.

R. E. Reedy, director of the newly created SST program office, Lockheed California Co., a division of Lockheed Aircraft Corp., Burbank, Calif. Also, **Warren F. Westermeier** appointed to the newly created post of rotary wing aircraft program director (XH-51A helicopter), Lockheed California Co.

William A. Boles, director of proposals, Aerospace/Rockets Div. of Bell Aerospace Corp., Buffalo, N. Y., a subsidiary of Textron Inc. **G. Jackson Butterbaugh** succeeds Mr. Boles as director of public relations for Bell Aerosystems Co., a division of Bell Aerospace Corp.

Glenn T. Stebbins, manager Western region, United Aircraft Corporate Systems Center, Sunnyvale, Calif.

Robert Hartle, chief engineer, Paraglider program, North American Aviation's Space and Information Systems Div., Downey, Calif.

David C. Fraley, system director of news and information services, American Airlines, Inc., and **Joseph M. Maran**, manager of information services.

L. L. Douglas, assistant general manager, product development and engineering, The Boeing Co.'s Vertol Div., Morton, Pa. **Robert W. Tharnagion** (AW Oct. 29, p. 39), Mr. Douglas and **Kenneth W. Brown**, assistant general manager operations, form a new Vertol Management Council. Other new appointments: **Charles E. Keeton**, director of finance; **John B. Brune, Jr.**, manager Material Dept.; **H. K. Burroughs**, administrative assistant to the general manager.

Charles W. George, general manager of the newly formed Radio Guidance Operation, Defense Electronics Div., General Electric Co., Syracuse, N. Y.

John A. Harper, regional director, Defense Systems Operations, Lear Siegler, Inc., with offices in Houston, Tex.

James F. Stevenson, Grumman Gulfstream sales manager for Pacific Armature Corp., Burbank, Calif.

B. J. Maynard, director of operations control, Douglas Missile & Space Systems Division, Santa Monica, Calif. **K. R. Williams** succeeds Mr. Maynard as manager of operations control. Appointments in the division's newly formed Marketing Dept.: **P. L. Smith**, manager market analysis; **F. F. Dunquette**, manager field operations management branch; **G. D. Morse**, manager market development; **J. W. Shaver**, manager international sales.

William F. Dougherty, Jr., head of the newly formed Solar Simulation Dept., Tennelec Engineering, Inc., Union, N. J.

Michael M. Marks, manager field and laboratory operations, Frederick Research Corp., Wheaton, Md.

William P. Peiser, general manager, Microwave Div., Sanders Associates, Inc., Nashua, N. H.

David L. Coddington, assistant to the senior vice president operations, Page Communications Engineers, Inc., Washington, D. C., a subsidiary of Northrop Corp. Also, **Jorgen H. Bistrup**, assistant director telecommunications directorate at Page.

George A. Brosnan, director engineering and operations, General Technology Corp., Torrance, Calif.

Glenn H. Siera, manager of the ANVMPQ-32 weapons locating program, Sylvania Electric Products, Inc., Waltham, Mass.

The Federal Aviation Agency has named the following to head new contracting branches in FAA's Installation and Material Service, Procurement Div.: **Ray E. Mulan**, Traffic Control and Radar Contracts Branch; **Harold N. Austin**, Communications and Weather Contracts Branch; **Richard T. Golnick**, Aircraft and Navaids Contracts Branch; **Frederick G. Bremer**, Facilities and Services Contracts Branch.

Jerome L. Herold, director of material and procurement, Space Systems Div., Martin Co., Baltimore, Md.

Dr. John E. Merrill, principal scientist, The Franklin Institute Laboratories, Philadelphia, Pa.

B. L. Eisenberger, marketing manager, product Aero-Space Division of Walter Kidde & Company, Inc., Belleville, N. J.

James P. Brown, director of marketing, Space Technology Laboratories, Inc., Redondo Beach, Calif., a subsidiary of Thompson-Ramo-Wooldridge, Inc.

Wendell F. Smith, marketing manager, ARACON Laboratories, a division of Allied Research Associates, Inc., Concord, Mass.

Daniel Shevelenko, director of engineering, Hathaway Instruments, Inc., Denver, Colo.

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b) **—be able to prepare specifications and technical planning for broadband microwave links consisting of a number of hops in tandem. Alternately, specify and plan the design of long haul repeater carrier, cable or open wire links.**

c) **—be able to develop plans for switched networks consisting of tandem trunks. Knowledge of signaling and supervisory requirements for voice, teletype, and/or data transmission is required, together with a sound basic knowledge of switching philosophy. Some knowledge of modern circuit and store and forward switching hardware is desirable.**

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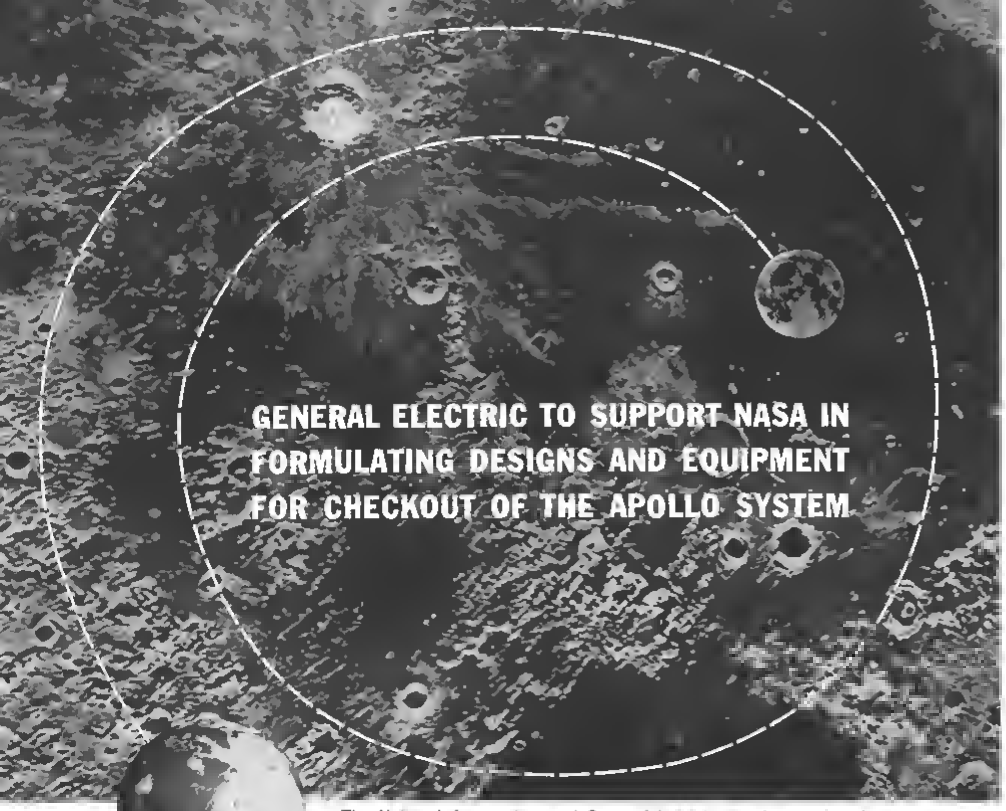

The National Aeronautics and Space Administration has assigned to General Electric a major role in designing and developing integrated, automatic checkout and test equipment for the APOLLO program, in addition to supporting NASA in overall reliability of the entire system. High level specialists and systems people are being drawn from many components of the company to contribute to the design and development of computerized semi-automatic and automatic checkout systems. Additional highly qualified engineers and scientists are needed now.

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COLUMBUS DIVISION
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LETTERS

F-105 Operation

The article in the Feb 25 issue (p 105) on our F-105D fighter-bomber wings in Germany was a shocker.

I had always thought that a fighter bomber should be capable of operating:

- Dependably with a minimum of maintenance
- In any terrain or weather without shelter
- With a minimum of test and support equipment which could be transported and operated easily
- From small, crude airstrips relatively close to the front line.

Obviously the era of electronics and computers has changed this concept.

The photograph of the F-105 flight line with 16 aircraft parked wingtip to wingtip in a straight line was a lovely sight—particularly to a MiG pilot coming in on the deck or a saboteur with a recoiless rifle. Considering how well these aircraft are dispersed the enemy would probably destroy only about 80% of the aircraft on the ground.

If our fighter-bombers can't fly without an umbilical cord attached to test equipment, let's put our money in missiles supported by reconnaissance drones.

E E Prince
Basking Ridge, N J

Dialers Lament

Mr Fierston's contest idea is pretty good (AW Feb 25, p 124), but I couldn't win because generally I manage to get an answer between two and three minutes and he has already outlasted me.

I propose a modification of the contest rules. Let's include those frustrated customers who direct dial (say, from Bridgeport to New York), finally manage to get an answer which hurriedly states in carefully modulated tones 'Reservations, XYZ Airlines ... please hold the line a minute!' At this juncture, before the unwary customer can explain that he is calling long distance, there is a click and there you are out on the end of the limb trying to decide whether to try it again, call person to person, or wait the necessary minute or two I have waited, by actual desk-clock count, as long as five minutes. The pleasant apology did not pay for the telephone call.

Even if one tries to get a word in edgewise to explain his long distance status the message never seems to get through. Click!

E T Manning
Stratford, Conn

'Rabid' Opinions

Although Maj William C Redeen (Letters, AW Oct 8, p 128) did not intend to be rabid in his analysis of the TWA crew's reaction to their 720B engine failure, his letter leaves no doubt in the readers' mind that he most certainly was if we are to define "rabid" as "one who is excessive in his beliefs or opinions" (Webster).

He intimates that he is the lone survivor of his graduating class of '37 due to his faultless lightning reactions during emergencies. This might be statistically so, but I think it is unworthy of the major to cast aspersions on his not so lucky compatriots considering there have been two wars in the intervening time.

He follows this up by suggesting that professional standards are required to fly jets that piston crews never had or are capable of getting—'and perhaps you can't use yesterday guys in tomorrow jobs.' This is the most extraordinary statement I have ever heard from a professional pilot. Forgetting the obvious derogatory implications of his remarks, and accepting the major's unqualified assumption that jets are more difficult to handle than props, one must muse on the frame of mind Maj. Redeen had when he checked out on jets. One also wonders where the airlines are going to recruit these all jet crews from and what sort of passengers would be willing to gamble their lives with their limited flight experience.

There is no escaping the fact that there is no substitute for time spent in the air. More time than less, in one type of equipment will make a crew feel more at home in the cockpit, and it will also enable them to analyze a mechanical problem peculiar to that piece of equipment more efficiently. However the action the crew takes is an variably dictated by their accumulative flight experience in all types of equipment. Then, of course, extending the major's facile argument that yesterday guys are incapable of tomorrow jobs one wonder how on earth we are going to recruit more astronauts of the caliber of Glenn and Schirra who had no previous astronaut experience.

The major's insistence that quick action is more vital to safety than any other factor is also wide open to question. As it is I know of no crews in scheduled or military flying that encourage flashing hands that press buttons and flick switches at the first instance of a twitching oil pressure gage. Today's equipment is redundantly designed, possible failures, even when imminent, permit a careful and methodical analysis without fear that the safety of the airplane will be jeopardized by the loss of that unit. How many accidents are there on record where the crew feathered the wrong engine in their haste to tackle a problem?

Finally I think it is highly presumptuous of anyone to condemn a crew for the way they reacted to a problem solely on the basis of a CAB report, particularly in this case, because had they not carried out their duties in the best interests of safety the CAB would have had no compunction about stating so. Only the crew in the light of their years of experience and the existing circumstances and conditions can readily evaluate a problem and determine the course of action to be taken. As it was, in this case speeding hands even with forethought would not have saved this engine as the foundation for its loss was laid on the ground by an erring mechanic—who perhaps, too was in a hurry.

G A Fulford
Seattle, Wash.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Wrong Drone

The following is offered in the interest of accuracy.

The Redeye missile article (AW Dec 24, p 19) indicated that this missile has engaged PB4Y, F9F and Beech KD2B drone aircraft. The statement that the Beech KD2B has been used in the program is incorrect. To date no firings have been made against the KDB. KDB being the designation we assume the article intended. The assumption is based on the fact that the KD2B (XKD2B) is a rocket rather than propeller driven.

The drone which has been in constant usage in the Redeye program since 1960 is the KD2R-5, a familiar product of Northrop Ventura (formerly Radioplane).

Jack Bean
Northrop Ventura Flight Service
China Lake, Calif.

(Mr. Bean is correct.—Ed.)

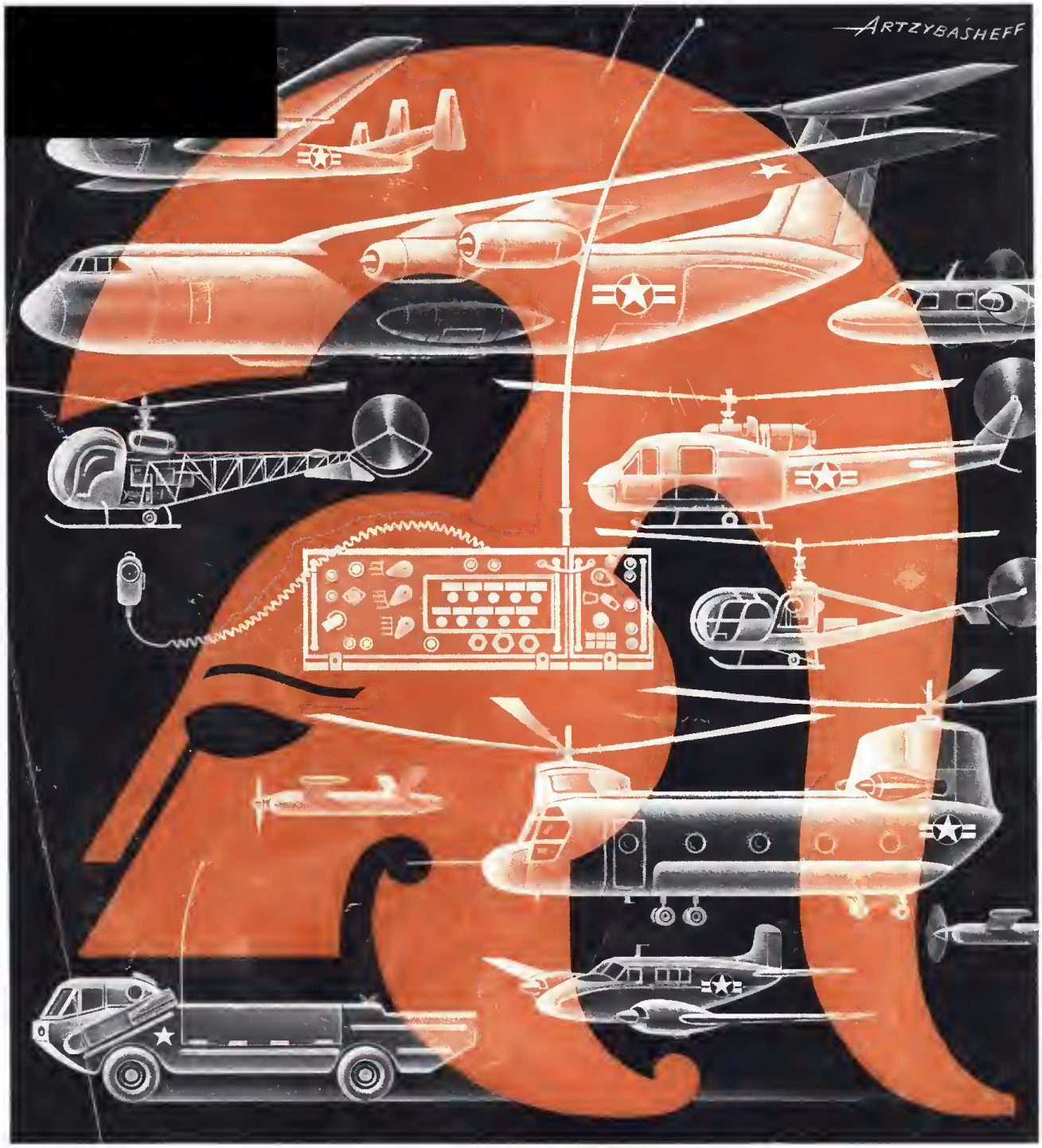
MATS Policy

In his letter to the editor (AW Feb 25, p 124) Mr Howard L. French has raised some important issues concerning the MATS policy of call business. Although I do not agree with his criticism of foreign aid and defense spending, I do feel that his questions rate very high on their own merits.

Quite a large number of flight personnel from many airlines have been laid off in the past few weeks. Needed supplies destined for overseas bases do seem to be pyramiding at ports of aerial embarkation. A few air carriers, such as the Flying Tiger Line, have had to purchase pure jet equipment, although they already have a fleet of turbine powered equipment in this case because of the Military Air Transport Service's emphasis on turbine power for their primary contractors.

The financial problems of these prospective bidders are severe, and they are not being lessened by the present fiscal policy as practiced in MATS. Herein lies still another question which I now add to those of Mr. French. Has "call flying" been reduced because of inadequate funds? Or has it been reduced because the appropriations adequate at the beginning of the fiscal year have been poorly budgeted and are now dwindling? Will an upsurge in this category of flying therefore have to wait until this coming July?

James J. Brophy
Flight Navigator
Los Angeles, Calif.



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